U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-290 969

Light Duty Vehicle Driveability Investigation

Suntech, Inc, Marcus Hook, PA

Prepared for

Environmental Protection Agency, Ann Arbor, MI

Dec 78

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-460/3-78-012	2.	3. RECIPIENT'S ACCESSION NO. PB290969
4. TITLE AND SUBTITLE Light Duty Vehicle Driveability Investigation		5. REPORT DATE December, 1978
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) H. A. Toulmin, Jr.		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Suntech, Inc. P.O. Box 1135 Marcus Hook, PA 19061		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-03-2607
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Protection Agency 2565 Plymouth Road Ann Arbor, MI 48105		13. TYPE OF REPORT AND PERIOD COVERED
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report describes the results of an automobile driveability, emission, fuel economy and performance testing program conducted for the U.S. Environmental Protection Agency. A total of twenty-two 1977 and 1978 model vehicles were subjected to a series of tests when adjusted to the manufacturers' recommended settings and when adjusted to simulate maladjustments found on in-use vehicles in an earlier EPA Restorative Maintenance Evaluation Project. The CRC driveability tests were performed on a weather controlled large roll chassis dynamometer at 16°C and the emissions and fuel economy tests were conducted according to the 1975 Federal Test Procedure, except that evaporative emissions tests were not conducted.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Driveability Exhaust Emissions Fuel Economy Acceleration Performance	Light Duty Vehicles 1975 FTP Emission Tests Driveability Tests Performance Tests	

18. DISTRIBUTION STATEMENT Unlimited	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES 435
	20. SECURITY CLASS *(This page)*	22. PRICE PC A19 MF A01

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

United States
Environmental Protection
Agency

Motor Vehicle Emission Lab
2565 Plymouth Rd.
Ann Arbor, Michigan 48105

EPA-460/3-78-012
December 1978

PB 290969

Air

EPA

Light Duty Vehicle Driveability Investigation

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

EPA-460/3-78-012

LIGHT DUTY VEHICLE DRIVEABILITY INVESTIGATION

BY
H. A. TOULMIN, JR.
SUNTECH, INC.
P.O. BOX 1135
MARCUS HOOK, PA 19061

CONTRACT NO. 68-03-2607
EPA PROJECT OFFICER: ANDREW W. KAUPERT

PREPARED FOR:
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR, NOISE AND RADIATION
OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL
EMISSION CONTROL TECHNOLOGY DIVISION
CHARACTERIZATION AND APPLICATIONS BRANCH
ANN ARBOR, MICHIGAN 48105

DECEMBER, 1978

This report is issued by the Environmental Protection Agency to disseminate technical data of interest to a limited number of readers. Copies are available free of charge to Federal employees, current contractors and grantees, and nonprofit organizations - in limited quantities - from the Library, Motor Vehicle Emission Laboratory, Ann Arbor, Michigan 48105, or, for a fee, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

This report was furnished to the Environmental Protection Agency by Suntech, Inc., P.O. Box 1135, Marcus Hook, PA 19061, in fulfillment of Contract No. 68-03-2607. The contents of this report are reproduced herein as received from Suntech, Inc.. The opinions, findings, and conclusions expressed are those of the author and not necessarily those of the Environmental Protection Agency. Mention of company or product names is not to be considered as an endorsement by the Environmental Protection Agency.

ABSTRACT

This report describes the results of an automobile driveability, emission, fuel economy and performance testing program conducted for the U.S. Environmental Protection Agency. A total of twenty-two 1977 and 1978 model vehicles were subjected to a series of tests when adjusted to the manufacturers' recommended settings and when adjusted to simulate maladjustments found on in-use vehicles in an earlier EPA Restorative Maintenance Evaluation Project. The CRC driveability tests were performed on a weather controlled large roll chassis dynamometer at 16°C and the emissions and fuel economy tests were conducted according to the 1975 Federal Test Procedure, except that evaporative emissions tests were not conducted.

FOREWORD

This project was initiated by the Characterization and Applications Branch, Division of Emission Control Technology, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan, 48105. The engineering effort on which this report is based was accomplished by the Automotive Laboratory of Suntech, Inc., P.O. Box 1135, Marcus Hook, Pennsylvania. The project was authorized by Contract 68-03-2607 and began on September 28, 1977 and was completed October 5, 1978.

The Suntech Project Leader was Dr. Robert E. Burtner, who supervised all of the work in the Marcus Hook Laboratory. Mr. Harry A. Toulmin, Jr. was Project Manager.

The Project Officer for this project was Mr. Andrew W. Kaupert, of the Characterization and Applications Branch, Environmental Protection Agency.

TABLE OF CONTENTS

Page

ABSTRACT iii

FOREWORD iv

LIST OF FIGURES vii

LIST OF TABLES viii

SUMMARY ix

I. Introduction 1

II. Equipment, Instruments, Preparations and Procedures 2

- A. Vehicle Selection and Procurement 2
- B. Car Preparation 4
- C. Emission System Maladjustments 5
- D. Test Fuels 5
- E. Driveability Test Procedure 6
- F. Emission and Fuel Economy Tests 8
- G. Acceleration Procedure 9

III. Description of Test Program 10

- A. Sequence of Testing 10
- B. Baseline Vehicle Tests 10
- C. Maladjusted Vehicle Tests 17
    - 1. Effect of Disconnecting ECR 17
    - 2. Effect of Rich Idle Mixture 19
    - 3. Effect of Richer Choke Settings 21
    - 4. Effect of Advancing Spark 21
    - 5. Effect of Increased Idle RPM 24
    - 6. Turbocharged Buick Maladjustments 24
    - 7. Three-Way Catalysts Maladjustments 26
    - 8. Effect of Multiple Maladjustments 26

IV. Recommendations 30

List of References 31

Appendix A

Engine Settings Used in Baseline Tests 32

Test Data from Vehicles on Baseline and Maladjustment Tests 34

TABLE OF CONTENTS (Continued)

Page

Appendix B

Driveability Test Procedure 57
Description of Emission Lab Instrumentation 65

Appendix C

Repeatability Data on Emission and Fuel Economy 66
Test Data for Individual Runs on Each Vehicle 68

Appendix D

Plots of Driveability vs. Acceleration Time, FTP Fuel Consumption, HFET Fuel Consumption and HC, CO and NOx Emissions on an Absolute Basis 90

Plots of Driveability vs. Acceleration Time, FTP Fuel Consumption, HFET Fuel Consumption and HC, CO and NOx Emissions on a Normalized Basis 258

LIST OF FIGURES

Figure | Page
1. Diagram of Testing Sequences for Vehicle Tests 11
2. Distribution of Driveability Demerits for all Cars Tested 13
3. Comparison of Driveability Demerits with Results of CRC Tests on 1973, 1975 and 1977 Model Vehicles 14

LIST OF TABLES

Table		Page
1	Driveability, Performance, Emission and Fuel Economy with Baseline Adjustments	12
2	Stalls During Driveability Runs	16
3	Effect of Disconnecting EGR on Vehicle Driveability, Emissions, Fuel Economy and Acceleration Time	18
4	Effect of Rich Idle on Vehicle Driveability, Emissions, Fuel Economy and Acceleration Time	20
5	Effect of Rich Choke Setting on Vehicle Driveability, Emissions, Fuel Economy and Acceleration Time	22
6	Effect of Advancing Spark on Vehicle Driveability, Emissions, Fuel Economy and Acceleration Time	23
7	Effect of Increased Idle RPM on Vehicle Driveability, Emissions, Fuel Economy and Acceleration Time	25
8	Effect of Multiple Maladjustments of Vehicle Driveability, Emissions, Fuel Economy and Acceleration Time	27
9	Summary of "Fleet Average" Effects of Maladjustments on Vehicle Driveability, Emissions, Fuel Economy and Acceleration Time	29

SUMMARY

Twenty-two 1977 and 1978 passenger cars selected on the basis of high sales volume and emission control technology were used to investigate and quantify the relationship between prevalent engine maladjustments found in in-use vehicles(1)* and their effect on vehicle driveability, exhaust emissions, fuel economy and acceleration. Each vehicle was driveability tested in accordance with the CRC Driveability Procedure(2) at 16°C and exhaust emissions and fuel economy were determined by the 1975 Federal Test Procedure. Tests were conducted on a weather-controlled large roll chassis dynamometer. Each test vehicle was tested with all engine and emission control system settings according to the manufacturers' recommendations and also additional tests were run with four sets of maladjustments which were representative of maladjustments found on in-use vehicles in the EPA Restorative Maintenance Evaluation.

There was a large variation in the driveability ratings among vehicles when adjusted to standard settings. Driveability was improved by some of the maladjustments but made worse by others. The response to a given maladjustment varied widely among cars, probably because of the differences in the calibration compromises made in the standard settings among vehicles.

From an overall fleet standpoint, disconnecting EGR improved driveability by 31%, richer choke settings improved driveability by 27%, advancing spark timing improved driveability by 11%, increasing idle rpm by 9%. The richer idle settings decreased driveability by 4%.

These maladjustments frequently caused large changes in emissions with NOx increasing 190% when EGR was disconnected, 20% when the timing was advanced and 12% when the idle rpm was increased. The rich idle increased CO by 108% and the rich choke settings increased CO by 12%. The rich idle increased HC by 48% and increasing idle rpm decreased HC by 16%. All other maladjustments made less than 10% change in emissions.

Disconnecting EGR and advancing spark timing gave a slight improvement in fuel economy and increased idle rpm reduced fuel economy. Richer idle and richer choke settings changed fuel economy less than 1%.

Advancing the spark timing was the only modification that improved the vehicle acceleration performance to the point that the change might be perceptible to the driver (5%).

The overall average of the twenty cars with multiple maladjustments, similar to those found on many of the maladjusted cars in the Restorative Maintenance Evaluation Project, showed only a very slight improvement in driveability at the expense of 142% increase in CO, 53% increase in HC and a 13% increase in NOx. These maladjustments resulted in a 2% reduction in overall fuel economy and no change in acceleration performance.

A summary of the effects of the maladjustments is shown in Table 9.

---

* A number in parenthesis ( ) denotes references listed at the end of the report.

I. INTRODUCTION

Surveillance studies of exhaust emissions from in-use vehicles have been conducted by the U.S. Environmental Protection Agency (EPA) for a number of years. Results of these programs have indicated that a large percentage of in-use automobiles of the newest model year did not meet their exhaust emission standards when tested in the as-received condition. Because of this, EPA conducted a Restorative Maintenance Evaluation Project(1) on low-mileage 1975, 1976 and 1977 vehicles. This program concluded that maladjustments and disablements within the emission control system were primarily responsible for the poor emission performance. It appears that an important motivation for maladjustment is the owners' desire to improve the driveability characteristics of the vehicle.

The objective of this program was to investigate and quantify the relationship between prevalent engine maladjustments and their effect on driveability. Simultaneously, emissions, acceleration performance and fuel economy were also measured.

II EQUIPMENT, INSTRUMENTS, PREPARATIONS AND PROCEDURES

This section describes the vehicles, facilities, instrumentation, procedures and fuels utilized in this project.

A. Vehicle Selection and Procurement

Twenty-two 1977 and 1978 passenger cars were selected for this program. The vehicles were selected on the basis of engine sales volume and emission control technology. Sixteen of the vehicles were certified to meet the Federal emission standards and six were California models. All cars were equipped with automatic transmissions. The following cars were used on the program:

	Code*	Calibration	Displacement Liters	No. Cyl.	Carb. Bbls.	Catalyst
GM						
1977 Chevrolet Chevette	A	Fed.	1.6	L-4	1	Oxidizing
1977 Chevrolet Chevelle	B	Fed.	5.0	V-8	2	"
1977 Pontiac Sunbird	C	Cal.	2.5	L-4	2	3-Way
1978 Pontiac Grand Prix	D	Fed.	4.9	V-8	2	Oxidizing
1977 Buick Skylark	E	Fed.	3.8	V-6	2	"
1977 Buick Century	F	Fed.	5.7	V-8	2	"
1978 Buick Regal	G	Fed.	3.8	V-6	4(1)	"
1977 Oldsmobile Cutlass	H	Fed.	5.7	V-8	4	"
1977 Oldsmobile 98	I	Fed.	6.6	V-8	4	"
FORD						
1977 Ford Pinto	J	Fed.	2.3	L-4	2	Oxidizing
1977 Ford Maverick	K	Fed.	4.1	L-6	1	"
1977 Ford Maverick	L	Cal.	4.1	L-6	1	"
1977 Granada	M	Fed.	5.0	V-8	2	"
1977 Ford Granada	N	Cal.	5.0	V-8	2(2)	"
1977 Ford LTD II	O	Fed.	5.8	V-8	2	"
CHRYSLER						
1977 Plymouth Volare	P	Fed.	3.7	L-6	1	Oxidizing
1977 Plymouth Volare	Q	Fed.	5.2	V-8	2	"
1977 Plymouth Volare	R	Cal.	5.2	V-8	2	"
1977 Chrysler Cordoba	S	Fed.	6.6	V-8	4(3)	"

	Code*	Calibration	Displacement Liters	No. Cyl.	Carb. Bbls.	Catalyst
AMC						
1978 AMC Concord	T	Cal.	4.2	L-6	1	Oxidizing
IMPORTS						
1978 Toyota Corolla	U	Fed.	1.6	L-4	2	Oxodizing
1978 Volvo 245-DL	V	Cal.	2.1	L-4	FI(4)	3-Way

---

* This letter code used to identify vehicles on tables in Appendix.

(1) Turbocharged

(2) Two-barrel variable venturi carburetor

(3) "Electronic Lean Burn" emission system

(4) Port Fuel Injection System

Most of the vehicles were leased from rental or leasing agencies or automotive dealers and three of the vehicles were from the Suntech vehicle fleet. Because of problems obtaining some of the California vehicles, three were obtained from oil and additive companies and one was on loan from the manufacturer. An attempt was made to obtain all of the vehicles with between 4,000 and 15,000 accumulated miles, but in a few cases the only vehicles available had mileage outside this limit. The following vehicles were tested at mileages outside this limit:

Ford Maverick	4.1 liter	California calibration	27,800 miles
Plymouth Volare	5.2 liter	California calibration	25,748
AMC Concord	4.2 liter	California calibration	1,985 miles
Volvo 245-DL	2.1 liter	California calibration	2,020 miles
Pontiac Sunbird	2.5 liter	California calibration	33,470 miles
Chevrolet Chevette	1.6 liter	Federal calibration	20,577 miles
Toyota Corolla	1.6 liter	Federal Calibration	3,813 miles

In our opinion the difference in mileage on these vehicles would not influence the ratings for these tests since all of the vehicles were thoroughly checked prior to test and parts, i.e., spark plugs and filters were replaced on vehicles with over 10,000 miles. (See Section B)

The mileage on each vehicle at the start of this program is shown on Table A-1 in Appendix A.

B. Car Preparation

Each test vehicle was set to the manufacturers' recommended settings before test, using the following check list:

1. New spark plugs were installed in all vehicles with over 10,000 miles of mileage accumulation.

2. The basic ignition timing and dwell (if equipped with breaker points) were set to manufacturers' specification.

3. The ignition system was scope tested to check for any malfunctions.

4. Carburetor air and fuel filters were replaced on vehicles with more than 10,000 miles.

5. The carburetor idle, and fast idle speed were set to manufacturers' specification.

6. The idle mixture was checked and reset if necessary by the procedure specified by the vehicle manufacturer. (Idle speed drop for GM, CO or propane enrichment for Ford and Chrysler, etc.)

7. The automatic choke mechanism and the choke vacuum break was set to specifications.

8. The EGR system was carefully checked to see that it was functioning properly.

9. All emission system linkages, hoses, heat valves, etc. were checked for proper connections and operation.

10. The oil was drained and refilled with an SE quality 10W-40 grade.

11. All fluid levels and tire pressures were checked.

12. A vacuum gauge and tachometer was installed for use in the driveability testing.

Recommended settings were obtained from the emission decal, engine shop manuals and from the engineering departments of the vehicle manufacturers. The settings used for the baseline tests are tabulated in Table A-1, Appendix A.

Most of the tune-up settings were obtained from the emission decal and the shop manuals without difficulty; however, in some cases the information was not available from these sources or from the local automobile dealers and had to be obtained directly from the manufacturers. Some of the information on models with running changes was obtained from service bulletins from the manufacturers.

C. Emission System Maladjustments

After each vehicle was run with the standard (baseline) settings, it was rerun at each of four maladjustment settings. These settings, which are detailed on the data summary tables, A-2 through A-23, of Appendix A, were obtained from EPA and represented settings and disablements found on similar vehicles in their Restorative Maintenance Evaluation Project(1). In most cases single maladjustments of one item were used on three of the tests and the fourth test was run with two or more maladjustments combined.

D. Test Fuels

All emissions tests, with the exception of one test run on the turbocharged Buick, were run on Indolene 0, as specified in the Federal Register. Acceleration tests, except on the turbocharged Buick, were run on this same fuel.

Indolene typically has a lower 90% evaporated point than the average commercial unleaded fuel in the marketplace and, therefore, the driveability of a vehicle will be different on Indolene than on a typical fuel. Inspections on recent batches of Indolene have indicated that the 90% point is about 158°C.

In order to make the program more meaningful, a test fuel meeting the following specifications was made up for the driveability testing:

	Specification	Max. ASTM D-439 Grade C	DOE	Fuel Used
10% Evaporated	51.7 ± 3°C	60°C	49.4°C	50.6°C
50% Evaporated	104.4 ± 3°C	116°C	105°C	107.2°C
90% Evaporated	173.9 ± 5°C	185°C	167.2°	170°C
RVP, KPa	62 to 76		67.6	65.5
Driveability Index*		238.5	213.3	217.5

* Driveability Index = 10% Pt/2 + 50% Pt + 90% Pt/2

This specification provides for a fuel that is slightly higher in driveability index than the average unleaded fuel from the Department of Energy Motor Gasoline Survey, BETC/PPS 78/1, but is well below the maximum limits of ASTM Standard D-439 Specifications for Automotive Gasoline. Inspection data for the fuel used in the program is shown in the table.

A third fuel was used in the program for one of the tests on the turbocharged Buick Regal. This fuel was specified by EPA as a high octane unleaded premium type fuel to determine the effect of the use of high octane fuel on the performance of this vehicle. A comparison of this fuel with the standard driveability fuel is shown in the following table:

	Special High Octane Fuel	Standard Driveability Fuel
Research Octane No.	101.0	93.4
Motor Octane No.	90.6	84.7
RVP, KPa	51.7	65.5
10% Evaporated, °C	67	51
50% Evaporated, °C	115	107
90% Evaporated, C	149	170
Driveability Index	223	217.5

E Driveability Test Procedure

The driveability quality of each car was evaluated by testing the vehicle using the Coordinating Research Council Cold Start Driveability Test Procedure(2) on a controlled weather large roll chassis dynamometer. This cycle simulates a 5.8 kilometer (3.6 mile) trip after starting from a cold soak at 15.6°C (60°F). The cycle consists of a series of full and part throttle accelerations performed at measured distances. Any vehicle malfunction such as a stall, back fire, hesitation, stumble or surge is evaluated by the driver and rated as to severity. These ratings are then translated into demerit ratings and combined into total demerits for the run. A detailed description of the test procedure can be found in Appendix B.

Before each driveability run, each vehicle is placed on the chassis dynamometer and driven for ten minutes at 97 kph in order to obtain equilibrium engine temperatures. The vehicle is then allowed to soak at the control temperature for three hours with the hood up and the room temperature maintained at 15.6°C and the cooling air velocity at 22 kph. Details of the cool down procedure can be found in Appendix B.

At the beginning of the program, each of the two test drivers made one of the driveability tests on each car. Since driveability rating is very subjective, there is always some difference in driveability rating, even among trained raters. This problem has been encountered on several CRC driveability programs.(2) (4) (5)

After the first eight cars were tested, it was decided to conduct all of the driveability runs on a car with one driver, since this would improve the repeatability of ratings and the objective of the program was to compare the effect of vehicle adjustment on driveability rather than to compare driveability differences among cars. The last fourteen cars to be tested used this procedure. The repeatability of the driveability test was improved from a standard deviation of 22.2 demerits for the first eight cars, using two drivers per car to 8.5 demerits for the second group of fourteen cars using the same driver for all of the runs on the car. The repeatability data was obtained, using the formula given below modified for duplicate tests for each car.

$$\text{Std. Dev.} = \sqrt{\frac{1}{N-1}\sum_{i+1}^{N}\left(\frac{\Delta}{2}\right)^{2}}$$

Where: Δ = Range between duplicate determinations

N = Number of duplicate determinations

Detailed driveability data on each vehicle is shown in Table C-2 through C-23 in Appendix C.

Up to 1968 when the CRC driveability procedure was developed, most of the driveability or "warm-up" tests reported in the literature were conducted to compare fuels of different distillation characteristics and were conducted using a road load and acceleration cycle on a chassis dynamometer. The CRC procedure was developed to incorporate more vehicle maneuvers so that it could be used to evaluate both vehicles and fuels.

In 1968-1970 Ethyl Corporation used this procedure to run an extensive driveability program for the Air Pollution Research Advisory Committee of CRC.(3) A fleet of twelve 1968, '69 and '70 model cars were driveability tested on the Ethyl large roll chassis dynamometer (which is very similar in all respects to the one used at Suntech) and then repeated some of the testing on the test track with an overnight soak before each run.

This correlation program, which seems to be the only one published in the literature, directly comparing driveability on the road and chassis dynamometers, compared the demerits obtained on two fuels in four test cars tested at 7°C on the dynamometer and at 4 to 10°C on the test track. The results were as follows:

Average Demerits From Duplicate Runs

	Fuel 1		Fuel 7	
	Dyn.	Road	Dyn.	Road
'69 Ford	57	37	186	155
'69 Rambler	134	53	202	137
'69 Olds	47	35	141	74
'69 Valiant	42	25	95	48
AVERAGE	70	38	156	104

When the demerits from the individual malfunctions were compared, the correlation was good for stalls, idle roughness and backfire, but "seat of pants" feel of vehicle movement (surge, hesitation and stumble) are magnified by the dynamometer. This CRC project concluded that the chassis dynamometer is a satisfactory method of making driveability evaluations but is more severe than road testing. The relative fuel rankings correlated fairly well between the two tests. Details of this study can be found in the CRC report.(3)

F. Emission and Fuel Economy Tests

The emission and fuel economy tests were conducted in accordance with the 1975 FTP procedure as specified in the Federal Register, Vol. 41, No. 177, September 10, 1976, except that the tests were run on a large single roll (1280 mm diameter) dynamometer and the room temperature was controlled to 22°C±2 to promote repeatability of runs. Evaporative emission tests were not run but the evaporative emission control system was stabilized before each soak by running an LA-4 test on Indolene immediately before each soak period. Details of the CVS test equipment and instrumentation is given in Appendix B-2. Vehicle inertia weight and horsepower settings were the same as used in the official EPA vehicle certification tests for the engine family.

The repeatability of the emission and fuel economy tests was calculated from the duplicate tests on each car. The coefficient of variation (CV) was calculated by standard statistical procedures although our method of assessing the standard deviation (S) may be more severe than at some other laboratories. Since only duplicate emissions results are normally obtained for each car modification,

we calculated S equal to $\sqrt{\frac{1}{N-1} \quad 2\left(\frac{\Delta}{2}\right)^2}$ five times for each car.

(Δ is simply the difference between duplicate tests, and $\frac{\Delta}{2}$ is the difference from the mean.)

This S value reduces to $\sqrt{\left(\frac{\Delta}{2}\right)^2}$ since N equals two and there are two $\frac{\Delta}{2}$ values.

Thus the standard deviation for each car is $S = \sqrt{\frac{S_1^2+S_2^2+S_3^2+S_4^2+S_5^2}{5}}$ for 10 testings.

The mean, $\overline{X}$, was simply obtained by averaging all the individual car runs and disregarding modification differences.

The following summary averages the coefficient of variation, (CV) (standard deviation, S, divided by the mean value, X) for the cars tested:

Emission Test Data	CV x 100%	Range, %
FTP Fuel Economy	1.9	0.5 to 5.3
Highway Fuel Economy	2.4	1.2 to 4.2
HC	9.5	4.0 to 20.6
CO	12.7	2.4 to 25.3
NOx	6.5	2.5 to 11.4

Detailed repeatability data on each vehicle is shown in Table C-1 in Appendix C.

G. Acceleration Procedure

The performance of each car was measured by determining the time for a 16.1 to 96.6 kph (10 to 60 mph) acceleration on the chassis dynamometer. The 16.1 kph starting speed was used to prevent wheel spin on the dynamometer rolls. The acceleration time was the average of six runs at each test condition. The dynamometer load and inertia settings were the same as used for the driveability tests of the car.

III. DESCRIPTION OF TEST PROGRAM

A. Sequence of Testing

In order to make maximum use of the chassis dynamometer facilities, the program was laid out so that a block of four cars would be run during each test period of approximately five weeks. The program layout is shown in Figure 1 for a typical week's operation.

Since each vehicle was tested by running duplicate runs at each of five adjustment conditions, baseline plus four maladjustments, each block of four cars could be completed in five weeks if no breakdowns of cars or equipment were encountered.

B. Baseline Vehicle Tests

Table 1 shows the results of the baseline tests (tests with all adjustments to manufacturers recommended setting). Figure 2 shows the distribution of the driveability demerits. The driveability varied considerably from a low of 12 demerits to a high of 269 demerits. (The lower the number of demerits the better the driveability.) Such variability is not unusual and similar results have been found in tests conducted on the road by CRC.

Figure 3 is taken from a recent CRC report(5) and shows a comparison of the average demerit level of three fleets of cars tested by CRC in three recent programs(4)(5)(6) plotted against the fuel volatility as expressed as the driveability index (in Fahrenheit units). The fuel used for this EPA program had a driveability index of 456 (217.5 in Celsius units) and the average demerit rating of the 22 cars is plotted against this driveability index. The plot indicates that the average car from this program has better driveability than the average 1973 and 1975 models tested by CRC but were poorer than the CRC 1977 models.

The difference between the 1977 models tested by CRC and those run on this program could have been due to differences in driver ratings, differences in the severity of ratings on the chassis dynamometer and the road, and the selection of the cars tested. It is well known that there are differences between expert driver ratings and CRC makes a statistical analysis of ratings from each driver used on each program and corrects the driver bias out.

As discussed in the previous section, the program conducted by Ethyl Corporation comparing driveability ratings on the chassis dynamometer and test track has indicated that the chassis ratings are slightly more severe than on the road although both cars and fuels were lined up in the same order. Since the purpose of this program was to determine differences in driveability due to changes in the car adjustment, the fact that the chassis dynamometer procedure may have been slightly more severe should make little difference in the relative ratings.

FIGURE 1

TYPICAL WEEKLY SCHEDULE FOR

DRIVEABILITY AND EMISSIONS TESTING

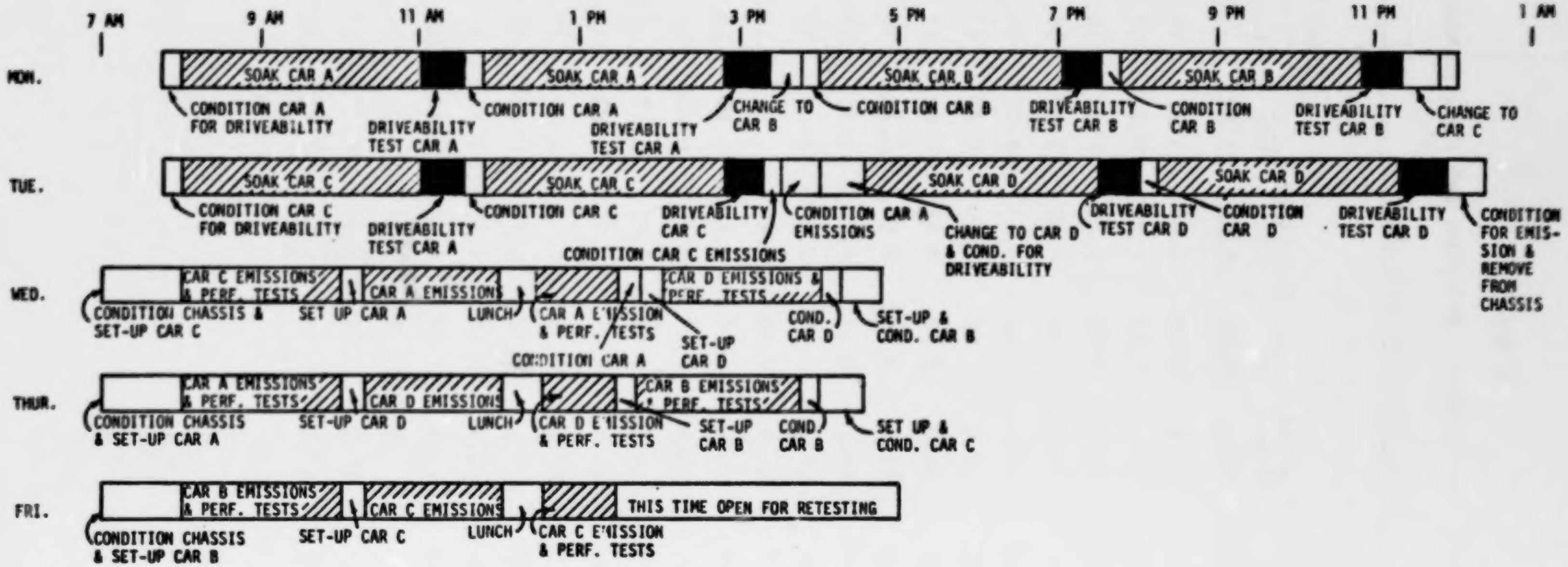


TABLE 1

DRIVEABILITY, PERFORMANCE, EMISSION AND FUEL ECONOMY WITH BASELINE ADJUSTMENTS

	Driveability Demerits	Accel. Time Sec.	Emissions			Fuel Consumption	
			HC gm/km	CO gm/km	NOx gm/km	Urban Liter/ 100 km	Highway Liter/ 100 km
Volare 318-C	269	11.8	0.29	2.06	1.17	22.25	15.19
Volare 318-F	244	10.1	0.63	7.23	0.89	18.62	13.24
Volare 225-F	238	14.4	0.83	6.76	1.12	14.40	11.10
LTD II 351W-F	211	10.4	0.79	6.42	1.50	17.07	12.25
Cordoba 400-F	185	9.7	0.42	3.63	1.07	20.70	13.63
Maverick 250-F	160	12.9	1.09	8.02	0.90	13.90	10.60
Pinto 140-F	154	14.0	0.54	9.48	0.90	12.70	9.60
Granada 302-C	150	11.4	0.46	3.04	0.70	19.30	13.50
Cutlass 350-F	127	10.1	0.47	4.73	1.25	16.12	11.87
Concord 258-C	121	17.4	0.19	3.46	0.69	17.83	15.00
Sunbird 151-C	117	14.9	0.50	5.44	1.21	10.88	8.32
Chevelle 305-F	117	10.6	0.63	8.16	1.69	16.08	12.60
Maverick 250-C	115	15.5	0.55	7.37	0.80	16.18	12.94
Chevette 98-F	109	14.2	0.63	9.77	1.12	9.89	7.26
Skylark 231-F	105	14.7	0.46	11.36	1.03	15.17	10.36
Century 350-F	105	11.9	0.51	6.55	1.04	16.33	11.88
Buick 231T-F*	91	10.1	0.50	6.15	0.78	14.51	11.21
Oldsmobile 403-F	84	9.7	0.51	4.65	1.59	16.49	12.06
Granada 302-F	83	11.1	1.14	4.62	1.27	16.05	12.35
Grand Prix 301-F	55	9.8	0.72	5.72	1.03	14.30	10.19
Volvo 130-C	17	14.0	0.20	2.04	0.42	12.58	9.27
Toyota 97-F	12	13.0	0.45	6.19	1.15	10.65	8.52

---

* Turbocharged

FIGURE 2

Distribution of Weighted Demerits with Baseline Settings

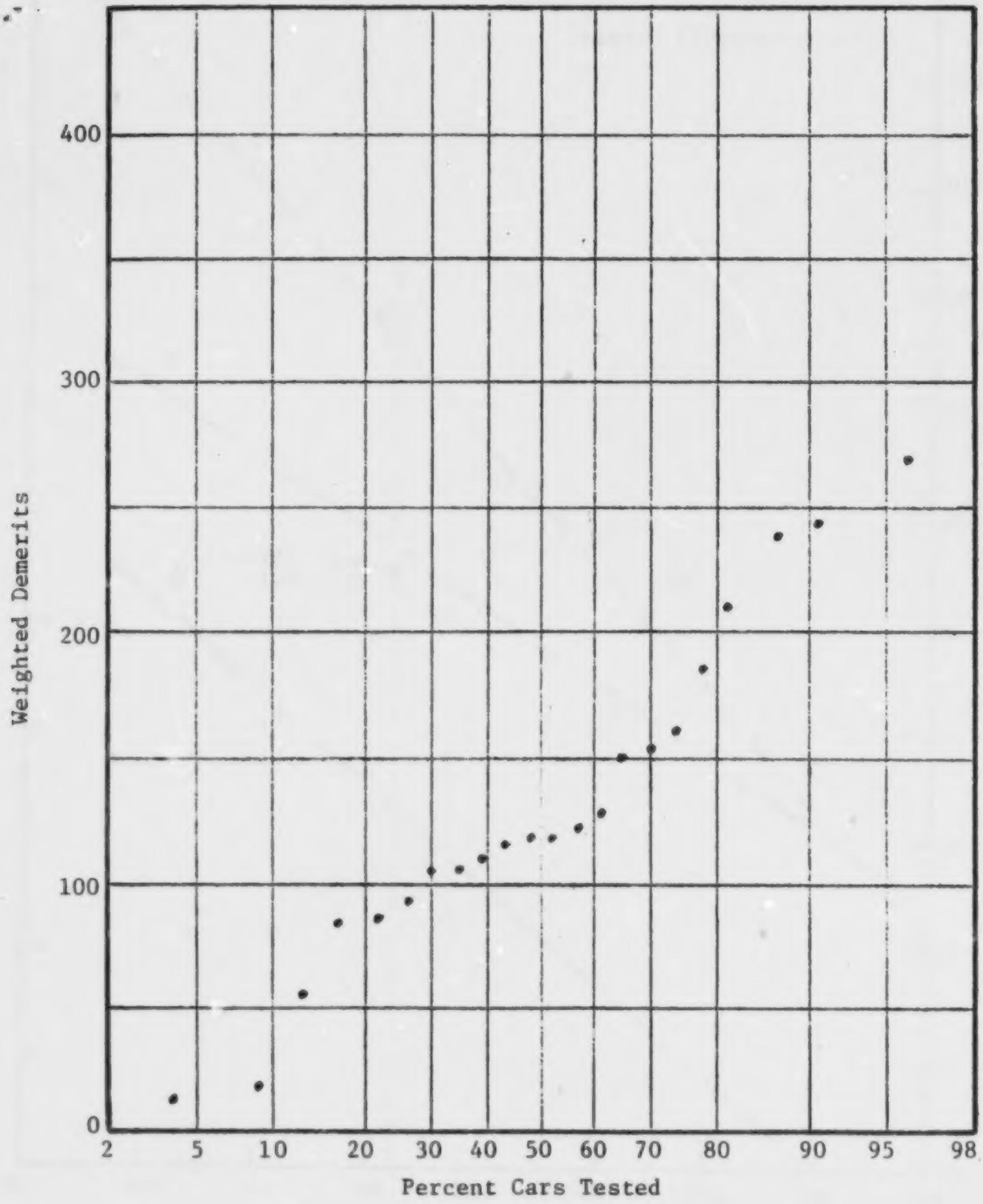
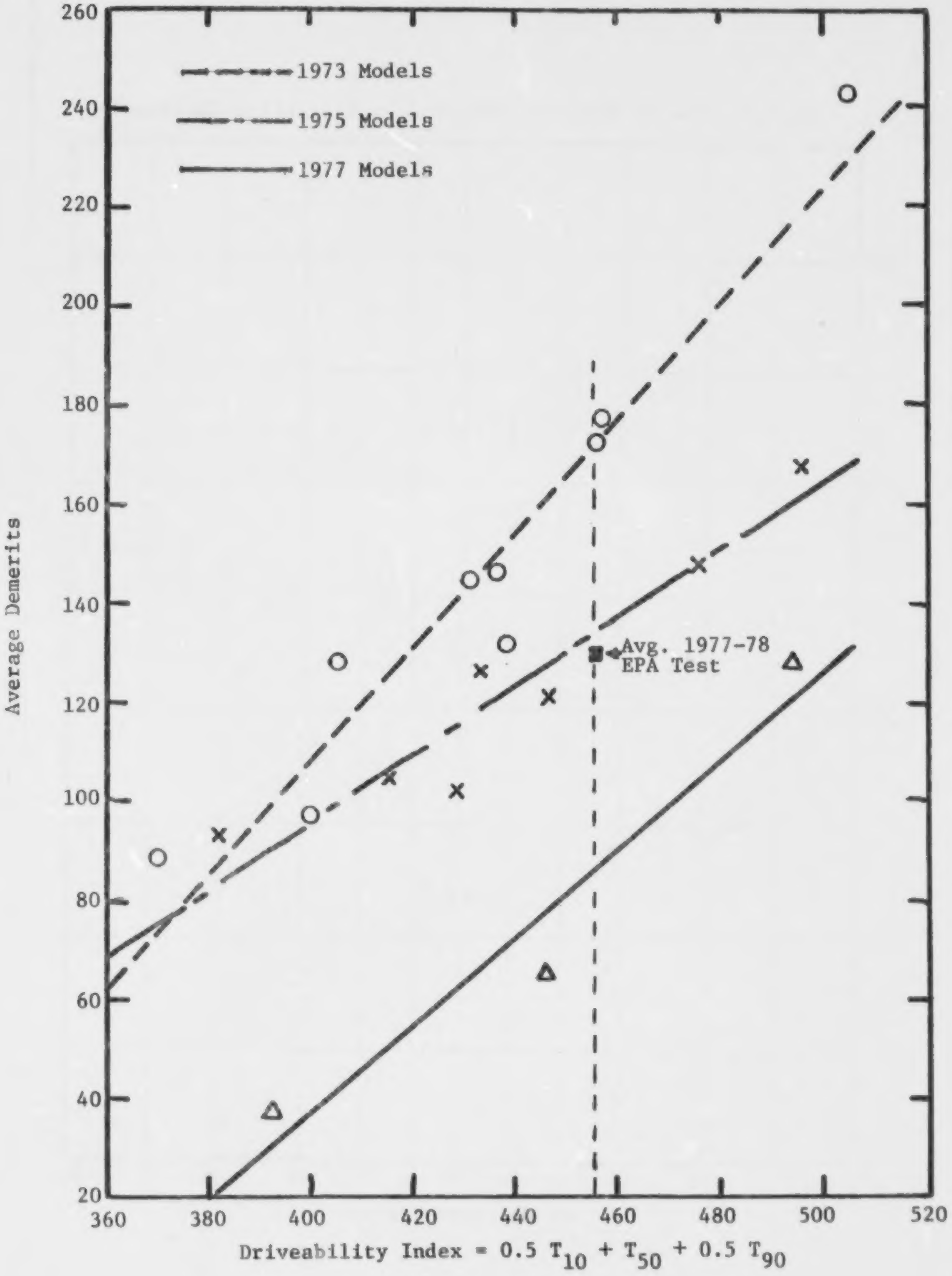


FIGURE 3

Driveability Comparison of Average of 1973, 1975 and 1977 Model Cars From CRC Tests$^{(6)}$ and 1977-78 EPA Test



There has never been any good agreement within the industry on the level of demerits which gives acceptable driveability. This is probably due to the fact that demerits are assigned for many types of malfunctions and different people have different sensitivity to different types of malfunctions. For instance, a car that stalls twice every time that it is tested may be very annoyable, yet it could finish a driveability test with an excellent rating if the driveability was good in other respects. (Two stalls after start-up only contribute 16 demerits.) A car with moderate surge, however, on each maneuver of the driveability test would accumulate 192 demerits, yet it might not be objectionable to some drivers because the car was always dependable during cold driveaway.

In the CRC 1977 test program,(5) a subprogram was conducted to compare driveability as evaluated by people not familiar with driveability testing ("customer" drivers) with the driveability performance as determined by trained raters. The "customer" evaluated driveability in his every-day use of the vehicle while the trained rater used the CRC driveability procedure. The ratings were determined by the five "customers" driving nineteen of the test cars on three different fuels of low, intermediate and high volatility. The trained rater demerits for these three fuels on the average of the 18 cars was 114.1, 59.1 and 32.6 respectively.

The CRC report concludes - "Five 'customer' drivers were able to distinguish among the three main program test fuels on the basis of volatility-related driveability problems. Their performance ratings indicated a high degree of annoyance with the least volatile fuel, but few problems with either of the other fuels."

This does not mean that there was a high degree of annoyance with car-fuel combinations that gave 114 demerits on the CRC procedure since only some of the cars on this fuel were rated low.

Although the program did not result in a go-nogo answer to the level of demerits that are acceptable, it did indicate that the "customer" drivers ranked the fuels much the same as trained drivers did under controlled conditions and also concluded that the "customer" is critical only if major malfunctions are observed.

It is apparent that much more work needs to be done on evaluating the relationship between the customers tolerance to driveability and the ratings obtained on a repetitive test procedure.

Table 2 summarizes the number of stalls obtained during all of the driveability tests. The idle stalls usually occur immediately after the cold start or when the transmission is shifted from park to drive. The moving stalls occur during attempted acceleration maneuvers. The idle stalls can be very annoying and the moving stalls can be dangerous if they occur in traffic. Since the cars are listed in the order of decreasing driveability demerits, it is obvious that there is only a slight correlation between the driveability demerits and the number of stalls.

TABLE 2

STALLS DURING DRIVEABILITY RUNS

	Runs	Idle Stalls	Idle Stalls/ Run	Moving Stalls	Moving Stalls/ Run	Total Stalls/ Run
Volare 318-C	10	9	0.9	10	1.0	1.9
Volare 318-F	12	18	1.5	7	0.6	2.1
Volare 225-F	14	13	0.9	34	2.4	3.3
LTD 351W-F	10	14	1.4	15	1.5	2.9
Cordoba 400-F	10	8	0.8	0	0	0.8
Maverick 250-F	10	0	0	5	0.5	0.5
Pinto 140-F	10	2	0.2	7	0.7	0.9
Granada 302-C	14	4	0.3	6	0.4	0.7
Cutlass 350-F	13	0	0	0	0	0
Concord 258-C	10	0	0	1	0.1	0.1
Sunbird 151-C	14	0	0	18	1.3	1.3
Chevelle 305-F	11	4	0.4	11	1.0	1.4
Maverick 250-C	8	0	0	0	0	0
Chevette 98-F	10	5	0.5	8	0.8	1.3
Skylark 231-F	10	0	0	0	0	0
Century 350-F	10	0	0	4	0.4	0.4
Buick 231T-F	10	0	0	10	1.0	1.0
Olds 98 403-F	10	0	0	1	0.1	0.1
Granada 302-F	10	7	0.7	4	0.4	1.1
Grand Prix 301-F	10	0	0	0	0	0
Volvo 130-C	10	0	0	0	0	0
Toyota 97-F	10	0	0	0	0	0

Most of the Federal calibration cars met the 1977 Federal emission standards and those that did not were very close to the limits. The fleet average was 31% below the standards for HC, 27% for CO and 33% for NOx.

Only two of the California cars met the emission standards on all pollutants. California cars were difficult to obtain on the East coast and the four cars that did not meet the limits were all laboratory test cars that had previously been used in other emission programs. After running a number of tests on the Maverick 250 vehicle, thoroughly checking the components of the emission system and rebuilding the carburetor, we found that the emissions were still high and CO was unstable from run to run, so this vehicle has not been included in the data analysis.

C. Maladjusted Vehicle Tests

The maladjustments used in this program were obtained from EPA and represented settings and disablements found to be prevalent in their "Restorative Maintenance Evaluation Project". Since the maladjustments differed from vehicle to vehicle, the effect of a class of maladjustment can best be evaluated by comparing the results on all of the vehicles upon which the maladjustment was used.

1. Effect of Disconnecting the Exhaust Gas Recirculation Valve

This maladjustment was performed on all of the vehicles which used EGR valves. The results are shown in Table 3, divided into three categories of emission systems; i.e., Federal systems with oxidizing catalyst, California systems with oxidizing catalyst, and one car with a three-way catalyst system. Disconnecting the EGR valve improved driveability an average of 21%* on the Federal emission control vehicles. Generally disconnecting the EGR valve reduced or eliminated surge when it was present on baseline tests and reduced hesitation on acceleration tip-in.

Although individual cars showed both higher and lower HC and CO emissions, the average emissions of the fleet were the same. Disconnecting the EGR gave the expected large increase in NOx emissions with the average of the fleet increasing by 210%. The average fuel economy was improved slightly and the acceleration rate was also improved slightly. The change in acceleration rate was probably due to the fact that the accelerations were made from road load 16.1 kph where the EGR would be functioning on the baseline runs.

---

* Fleet average percent change in Tables 3 through 8 is calculated by comparing the average demerits, emissions, or acceleration time from all of the vehicles with the particular maladjustment with the average from the baseline tests. The fuel economy percent change is calculated by comparing the reciprocal of the average of the fuel consumption measurements from the vehicles with maladjustments with the reciprocal of the average from the baseline.

TABLE 3

EFFECT OF DISCONNECTING EGR ON VEHICLE DRIVEABILITY, EMISSIONS, FUEL ECONOMY AND ACCELERATION TIME

PERCENT CHANGE FROM BASELINE

	Driveability Demerits	Emissions			Fuel Economy		Accel. Time
		HC	CO	NOx	Urban	Highway	
Volare 318-F	-20	-13	+ 7	+ 85	+ 6.6	+ 5.3	- 2.2
Volare 225-F	-35	+ 8	+ 6	+252	+10.7	+12.1	- 3.5
LTD II 351W-F	-40	- 6	+ 3	+248	- 1.6	- 2.7	+ 0.5
Maverick 250-F	-20	-26	+ 2	+430	+ 1.2	- 2.2	- 2.3
Pinto 140-F	- 1	+ 2	+ 6	+186	+ 6.1	+ 8.8	- 5.7
Cutlass 350-F	-34	- 1	-13	+280	+ 0.7	+ 2.7	- 1.4
Chevelle 305-F	+ 1	+14	+12	+ 36	+ 2.3	+ 6.3	- 0.8
Chevette 98-F	-18	-21	-21	+173	+ 0.5	- 2.6	- 3.5
Skylark 231-F	-25	+39	+10	+198	+10.0	+ 5.2	- 3.3
Century 350-F	-47	- 1	-10	+206	+ 3.7	+ 4.3	- 0.8
Regal 231-TF	-10	+ 6	+ 6	+227	- 6.7	- 9.6	- 2.4
Olds 403-F	+11	+13	- 3	+224	- 0.4	+ 0.4	- 0.5
Granada 302-F	-42	-11	+ 3	+252	- 0.1	- 4.6	- 1.4
Grand Prix 301-F	+40	+11	- 1	+214	- 3.2	- 5.0	- 0.5
FLEET AVERAGE	-21.2	- 1.4	+ 0.9	+210	+ 2.0	+ 1.1	- 2.2
Volare 318-C	-49	-23	-21	+ 60	+10.3	+16.2	0
Granada 302-C	-97	+26	-23	+206	+ 7.1	+ 4.7	+ 1.8
Concord 258-C	-72	-26	-45	+281	+15.7	+28.4	-26.7
FLEET AVERAGE	-67.8	0	-31.0	+159	+10.8	+16.0	-11.0
Sunbird 151-C	-10	-32	-11	- 3.1	- 0.3	- 5.1	- 2.0
TOTAL FLEET AVERAGE	-30.6	- 2.7	- 2.1	+190	+ 3.7	+ 3.7	- 3.8

The three California cars with oxidizing catalysts showed a much larger improvement in driveability when the EGR was disconnected. CO was reduced by 31% but NOx was increased by 159%. Fuel economy was improved considerably more on these California calibration cars than on the Federal cars both on a fleet average basis and on the two individual cars, Granada 302 and Volare 318, where a comparison can be made with their counterparts in the Federal fleet. The large change in acceleration time on the Concord 258 was due to the EGR valve opening at full throttle high engine speed. This is inherent in the calibration used on this engine.

Disconnecting the EGR on the one vehicle with a three-way catalyst made much less difference in driveability, economy and emissions than on the vehicles with oxidizing catalysts.

There are two side effects of disconnecting EGR that were not investigated as part of this program. The recycled exhaust gas lowers the part throttle octane requirement of the vehicle so disconnecting the EGR can increase the part throttle octane requirement of the vehicle and cause knock problems in vehicles with no part throttle knock with the normal calibration. Although knock observations were not specifically investigated in this program, knock was detected during the driveability test on the Pinto 140-F, Maverick 250-F and Granada 302-F during the runs with the EGR disconnected.

Also, disconnecting EGR can lead to a reduction in the service life of the clutches in automatic transmissions. The part throttle clutch pressure in automatic transmissions is calibrated to match the engine torque output in order to give smooth shifts. The transmission pressure is controlled by either a mechanical linkage from the carburetor throttle linkage or by a pressure modulator connected to manifold vacuum, depending on the make and model of the transmission. Disconnecting EGR changes the manifold vacuum or throttle position to engine torque relationship and results in lower clutch pressure during part throttle shifts. This can result in clutch slippage and shorten clutch life.

2. Effect of Rich Idle Mixture

The idle mixture was adjusted richer than specification on 15 of the vehicles, as shown on Table 4. The amount of enrichment used (see the last column of Table 4) was dependent upon the settings found on the EPA Restorative Maintenance Evaluation Program and was described by the CO at idle with the air pump, on those cars so equipped, bypassed. In most cases these settings were only slightly richer than the standard setting and all settings could be obtained within the limits of adjustment of the idle screws.

The fleet average driveability was not affected by the richer idle settings. Some vehicles improved considerably and some were made worse. The two vehicles with the largest percentage increase in driveability demerits with the richer mixture were the Volare 225-F and the Volvo 130-C. When the mixture on the Volare was enrichened it stumbled very badly on the part throttle accelerations even when approaching the end of the test. In order to be sure that this was due to the adjustment and not some other engine malfunction, the baseline and the rich idle runs were rerun twice with the same

TABLE 4

EFFECT OF RICH IDLE ON VEHICLE DRIVEABILITY, EMISSIONS, FUEL ECONOMY AND ACCELERATION TIME

PERCENT CHANGE FROM BASELINE

	Driveability Demerits	Emissions			Fuel Economy		Accel. Time	Idle Setting % CO
		HC	CO	NOx	Urban	Highway		
Volare 318-C	-22	+ 17	+ 7	-11	+3.5	+0.7	0	2%
Volare 318-F	+ 3	+ 46	+ 97	+ 8	-4.2	-1.8	-0.3	1%
Volare 225-F	+53	+ 51	+ 85	- 8	+4.4	+5.1	-2.8	4%
Cordoba 400-F	+15	+131	+397	- 1	-3.8	+2.5	+1.5	0.7%
Maverick 250-F	- 9	+ 42	+ 67	+ 3	+2.2	+3.2	-6.2	1%
Pinto 140-F	-40	+ 70	+ 91	- 1	+3.9	+7.2	-6.4	2%
Granada 302-C	-58	- 1	- 11	- 7	+2.1	+3.0	-1.8	2%
Concord 258-C	+ 5	- 3	+ 0	-13	+0.2	+3.5	-3.2	2%
Chevelle 305-F	+ 3	+126	+155	+ 2	+0.3	+4.9	-0.7	3%
Century 350-F	-17	+248	+379	-25	-7.1	-2.5	-2.0	3%
Regal 231T-F	-18	- 9	+ 76	-23	-7.5	+4.0	+1.9	2%
Granada 302-F	+48	- 32	+ 14	-22	-2.7	-3.0	+2.2	2%
Grand Prix 301-F	+22	+112	+151	+ 5	+0.6	+3.6	+0.4	1.5%
Volvo 130-C	+53	- 3	+ 19	+42	-2.1	-5.3	+2.1	4%
FLEET AVERAGE	+ 4.1	+ 48	+108	- 7.9	-0.9	+1.4	-1.2	

result. The Volvo 130-C had such low demerits on baseline that the increase in nine driveability demerits with the rich idle mixture was within the repeatability of the driveability procedure even though the percentage change was large.

The increase in HC and CO with idle enrichment varied widely among cars indicating that the effective mixture was being changed considerably more on some cars than on others. In future programs it would probably give more consistent results if the idle CO measurements were made ahead of the catalyst instead of downstream as used on this program and the Restorative Maintenance Program.

The total fleet average HC emissions were increased by almost 50% and the CO was more than doubled. The richer mixtures resulted in a slight reduction in NOx.

Urban and highway fuel economy and acceleration time showed very little change due to the change in idle mixtures.

3. Effect of Richer Choke Settings

The effect of richer choke settings was investigated on seven vehicles as shown in Table 5. The two Chrysler vehicles used electric choke heaters in the choke housing to increase the rate of choke heat. On these vehicles the electric heater was disconnected. The four GM cars and the Granada all used chokes with adjustable housings. These were set one notch richer on the Chevette, two notches richer on the Oldsmobile 98 and three notches richer on the other vehicles.

The richer chokes improved driveability by 27% on the fleet average and showed the largest effect on the cars where the choke housing was adjusted. The richer choke settings reduced the demerits due to a reduction in stumble. In cases where vehicles encountered idle and moving stalls on the baseline runs the richer choke settings reduced the number of stalls on the Volare and the Granada but did not eliminate them. It must be remembered that these driveability runs were only run at one temperature, 16°C (60F), and other temperatures would probably show different influences of the richer choke settings. As can be seen from the table, the choke settings had little effect on emissions, fuel economy and acceleration time of the vehicles.

4. Effect of Advancing Spark Timing

Spark timing was advanced on six of the vehicles, as shown in Table 6. Driveability was improved 11% on the fleet average. The Volvo had only 17 demerits on baseline, so the increase in percentage demerits was within the repeatability of the test even though the percentage is high. On an average the NOx was increased by 20% with little change in HC and CO emissions. Slight improvements were obtained on fuel economy. Advancing the spark was the only modification that improved the vehicle acceleration time to the point that it might be perceptible to the driver.

TABLE 5

EFFECT OF RICH CHOKE SETTING ON VEHICLE DRIVEABILITY, EMISSIONS, FUEL ECONOMY AND ACCELERATION TIME

PERCENT CHANGE FROM BASELINE

	Driveability Demerits	Emissions			Fuel Economy		Accel. Time	Change in Choke Setting
		HC	CO	NOx	Urban	Highway		
Volare 318-C	- 4	-21	- 6	-13	+3.5	+0.6	-1.7	(1)
Cordoba 400-F	-11	- 4	+44	+11	-5.1	-1.8	+1.6	(1)
Cutlass 350-F	-39	- 3	+25	- 5	-1.6	+0.4	-2.4	3-R
Chevette 98-F	-43	- 3	-13	- 3	+4.4	+3.7	-2.0	1-R
Skylark 231-F	-68	+35	+22	- 8	+4.3	+0.4	-0.5	3-R
Olds 98 403-F	-27	+ 4	+14	-12	+1.3	+4.1	+1.0	2-R
Granada 302-F	-43	+ 2	+ 6	+10	-1.8	-1.4	-1.0	3-R
FLEET AVERAGE	-27	+ 2.6	+12.3	- 3.3	+0.3	+0.6	-0.5	

(1) Disconnected electric choke heater

TABLE 6

EFFECT OF ADVANCING SPARK ON VEHICLE DRIVEABILITY EMISSIONS, FUEL ECONOMY AND ACCELERATION TIME

PERCENT CHANGE FROM BASELINE

	Drive-ability Demerits	Emissions			Fuel Economy		Accel. Time	Spark Advanced
		HC	CO	NOx	Urban	Highway		
Volare 225-F	-11	-10	-15	+ 8	+6.9	+5.9	-2.1	6°
LTD-II 351W-F	+12	- 5	- 1	+16	-2.2	-4.4	-3.1	4°
Cordoba 400-F	- 4	+ 6	+ 7	+18	-2.4	+2.4	-6.0	4°
Maverick 250-F	-39	0	- 4	+32	+4.7	+2.5	-4.7	6°
Pinto 140-F	-25	- 1	-19	+32	+8.7	+7.4	-10.7	6°
Volvo 130-C	+35	- 6	+17	+13	-0.6	-5.8	-1.4	5°
FLEET AVERAGE	-10.9	- 2.9	- 7.0	+19.6	+1.8	+1.1	-4.6	

It is well known that advancing the timing increases the knocking tendency of cars. Although knock was not monitored as part of this program, knock was observed on the Pinto 140-F and Maverick 250-F during the driveability tests with the advanced spark settings.

5. Effect of Increased Idle RPM

The idle rpm was increased on four of the cars as shown in Table 7.

The increased idle speed improved the driveability on three of the cars and was detrimental on the fourth. Generally, the increased rpm reduced the stumble demerits except for the Skylark and on this car the stumble demerits were greatly increased. HC and CO emissions were reduced with a slight increase in NOx.

Fuel economy, particularly on the urban cycle, was reduced and there was a slight improvement in acceleration time.

6. Turbocharged Buick Maladjustments

The turbocharged Buick Regal was treated as a special case. This vehicle uses a knock sensor to determine when the engine knocks and electronically retards the spark. Since the operating ignition timing would be different under knocking conditions when the vehicle is operating with a high octane fuel than on a normal regular unleaded fuel, the acceleration performance, and possibly the driveability, fuel economy and the emissions might be different.

The complete data on the performance of this car is shown on Table A-7 in Appendix A. The baseline acceleration runs were made on Sunlite unleaded gasoline of a nominal 91.5 Research octane number. When the accelerations were made on the special high octane fuel, described in Section II-D, the acceleration time was reduced by 9.5%. Driveability on this high octane fuel was 13% poorer than on the 93 octane driveability fuel but the driveability index of the high octane fuel was 223 (466 in °F units) compared to 217.5 (456) on the driveability fuel. Previous driveability/fuel volatility correlation programs would indicate that this change in driveability index should give about this change in driveability so it is believed that the high octane number of the test fuel had no effect on driveability.

This vehicle has an external connection to the control of carburetor power enrichment from the turbocharger boost pressure. If this hose is disconnected, the power enrichment valve will be open at all times. This modification improved driveability by 50% but the richer mixture at light loads reduced fuel economy by 13 to 14% and increased HC by 183% and CO by 745%. There was only a small improvement in acceleration time.

The idle CO and EGR disconnect modifications have been discussed in previous sections.

TABLE 7

EFFECT OF INCREASED IDLE RPM ON VEHICLE DRIVEABILITY EMISSIONS, FUEL ECONOMY AND ACCELERATION TIME

PERCENT CHANGE FROM BASELINE

	Drive-ability Demerits	Emissions			Fuel Economy		Accel.	Inc. Idle
		HC	CO	NOx	Urban	Highway	Time	Speed
Volare 318-F	- 7	-10	+25	+ 4	-5.7	-2.2	0	250
Cutlass 350-F	-44	- 9	- 1	+17	-6.4	-2.5	-1.3	125
Chevette 98-F	-11	-36	-15	+13	-5.8	-3.0	-3.5	125
Skylark 231-F	+32	- 4	-21	+11	+3.9	+1.0	-2.3	125
FLEET AVERAGE	- 9	-16.1	- 6.4	+11.9	-4.1	-1.6	-1.9	

7. Three-way Catalyst Vehicle Maladjustment

Two of the vehicles used on the program were equipped with California calibration emission systems using oxygen sensors in the exhaust for feedback control of the fuel-air ratio. When the oxygen sensors were disconnected the Volvo, which had excellent driveability in baseline condition, showed no change in driveability and the Sunbird showed a 15 to 24% improvement. On the Volvo, the richer fuel metering with the sensor disconnected reduced the fuel economy on the urban cycle by 2% and 5% on the highway cycle and resulted in increases of HC, CO and NOx emissions of 59%, 193% and 145%. When a combination of 5° advanced spark and a slightly richer idle were combined with the O_2 sensor disconnect, the HC was increased by 430% and the CO by 1200%.

The O_2 sensor disconnect on the Sunbird resulted in a 14% reduction in urban economy and a 13% reduction in highway economy. HC emissions were increased by 220% and CO by 1000%. NOx was reduced by 65%.

Complete data on these two cars is shown on Tables A-22 and A-23 in Appendix A.

8. Effect of Multiple Maladjustments

One of the modifications tested on all but one car in the fleet was the maladjustment of two and sometimes three items at one time. These combinations of maladjustments were similar to those found on many of the maladjusted cars in the Restorative Maintenance Evaluation Project. Since the type of maladjustment varied from car to car, it would not be expected that these maladjustments would have the same effect on driveability, emissions or fuel economy, but a fleet average of all of the tests may be representative of the portion of in-use cars with multiple maladjustments.

Table 8 shows the results of these tests divided into groups according to the type of emission control system. Details of the maladjustments to each car are given in Tables A-2 to A-23 in Appendix A.

The multiple maladjustments improved the driveability on nine of the Federal calibration cars and made it worse on six for a fleet average of 3% improvement. Emissions of HC, CO and NOx were increased considerably and urban fuel economy was reduced slightly. Highway fuel economy and acceleration performance were improved very slightly.

The California fleet with oxidizing catalysts, although of very limited sample size, showed a larger improvement in driveability and a smaller increase in HC and CO and a reduction in NOx. The modifications resulted in a slight reduction in fuel economy and acceleration performance.

The two California cars with three-way catalyst both showed large increases in HC and CO since one of the maladjustments on each car was the disconnect of the O_2 sensor, as discussed in the previous section.

TABLE 8

EFFECT OF MULTIPLE MALADJUSTMENTS OF VEHICLE DRIVEABILITY, EMISSIONS, FUEL ECONOMY AND ACCELERATION TIME

PERCENT CHANGE FROM BASELINE

	Drive-ability Demerits	Emissions			Fuel Economy		Accel. Time	Malad-justments
		HC	CO	NOx	Urban	Highway		
Volare 318-F	- 4	+ 37	+111	+ 13	-8.1	-2.8	-0.8	IRPM, ICO
Volare 225-F	+48	+ 55	+130	- 13	-0.2	+2.7	+0.7	IRPM, ICO
LTD 351W-F	+ 6	+ 15	+ 31	+ 19	-2.5	-7.1	-2.5	+ Spark, RRPM
Cordoba 400-F	+ 4	+140	+488	+ 12	-6.8	-4.3	-0.3	ICO, IRPM
Maverick 250-F	- 5	+ 63	+ 69	+ 19	-0.2	-0.5	-4.7	+ Spark, ICO
Pinto 140-F	-11	+ 49	+ 77	- 4	+1.4	+2.5	-5.7	IRPM, ICO
Cutlass 350-F	-33	+ 8	+ 55	+ 34	-6.1	-2.8	-3.2	Choke, IRPM
Chevelle 305-F	+16	+125	+190	- 8	-1.2	+4.8	+5.3	- Spark, ICO
Chevette 98-F	-35	- 30	- 18	+ 13	-8.0	-10.1	+0.7	Choke, IRPM
Skylark 231-F	-40	+ 81	+ 31	+187	+10.6	+5.1	-3.9	EGR, Choke
Century 350-F	-13	+162	+149	+163	+3.7	+4.5	-3.9	EGR,ICO
Olds 98 403-F	-54	- 13	+ 4	- 24	+1.1	+4.4	+1.6	Choke, IFI
Granada 302-F	+ 4	- 33	+ 44	- 28	-8.0	-8.2	+6.6	- Spark, ICO
Grand Prix 301-F	+ 9	+ 78	+185	+172	+1.3	+4.9	-3.7	EGR, ICO
Toyota 97-F	-100+	+ 10	+ 31	- 13	+1.1	-0.8	0.0	ICO, RFI
FLEET AVERAGE	- 3.4	+ 40.1	+ 80.9	+ 22.5	-2.1	+0.3	-0.9	
Volare 318-C	+15	+ 23	+133	- 13	-6.9	-6.3	+9.3	- Spark, ICO
Granada 302-C	-77	- 3	- 13	- 10	+3.7	-1.5	0	RRPM, ICO
Concord 258-C	-12	+ 39	+ 83	- 22	+4.9	+4.8	+3.2	Choke, ICO
FLEET AVERAGE	-16.9	+13.8	+ 61.1	- 14.4	-0.3	-1.2	+4.1	
Sunbird 151-C	-12	+216	+1024	- 64	-15.2	-13.9	-4.7	0_2, EGR
Volvo 130-C	+ 6	+431	+1210	+ 5	-3.2	-6.2	-2.1	0_2, + Spark, ICO
FLEET AVERAGE	- 9.7	+277	+1074	- 46.2	-9.2	-10.0	-3.5	
OVERALL AVERAGE	- 6.4	+ 52.5	+141.7	+ 13.0	-2.3	-0.8	-0.4	

IRPM = Increase Idle RPM
RRPM = Reduce Idle RPM
EGR = Disconnect EGR

Choke = Set choke richer
+ Spark = Advance spark
- Spark = Retard spark

0_2 = Disconnect 0_2 sensor
IFI = Increase fast idle
RFI = Reduce fast idle

The overall fleet with multiple maladjustments showed a slight improvement in driveability at the expense of higher emissions and a slight reduction in fuel economy and acceleration time.

Table 9 is a summary of the "fleet average" effects of maladjustments on vehicle driveability, emissions, fuel economy and acceleration time.

Appendix D contains plots of vehicle driveability vs. emissions, fuel economy and acceleration time for each vehicle on an absolute basis and on a normalized basis. It also contains plots of vehicle driveability vs. emissions, fuel economy and acceleration time on an absolute basis and on a normalized basis for each maladjustment.

TABLE 9

SUMMARY OF "FLEET AVERAGE" EFFECTS OF MALADJUSTMENTS ON VEHICLE DRIVEABILITY, EMISSIONS, FUEL ECONOMY AND ACCELERATION TIME

PERCENT CHANGE FROM BASELINE

	Driveability Demerits	Emissions			Fuel Economy		Accel. Time
		HC	CO	NOx	Urban	Highway	
Disconnect EGR	-31	- 3	- 2	+190	+4	+4	-4
Richer Idle	+ 4	+48	+108	- 8	-1	+1	-1
Richer Choke	-27	+ 3	+ 12	- 3	0	+1	-1
Advanced Spark	-11	- 3	- 7	+ 20	+2	+1	-5
Increased Idle RPM	- 9	-16	- 6	+ 12	-4	-2	-2
Multiple Maladjustment	- 6	+53	+142	+ 13	-2	-1	0

- Means improved driveability, reduced emissions, better acceleration performance, but poorer fuel economy.

IV. RECOMMENDATIONS

The results of this project has indicated that there is a wide variation in the driveability of various makes of 1977 and 1978 passenger cars when tested at 16°C and that the driveability can be improved by modifications in the engine adjustment. These modified adjustments usually cause large increases in vehicle emissions. This program was only conducted at a mild temperature (16°C) and a lower temperature more representative of normal winter operation should be investigated to see if the lower temperature would give different and probably more critical driveability. Also, some of the maladjustments such as richer choke settings would probably show different effects on vehicle emissions if the emission tests were run at lower temperature to simulate winter operation.

The CRC driveability procedure was developed in 1968 when engine calibrations were much different than at present. In general both carburetor and choke calibrations were much richer and exhaust gas recirculation or catalyst were not used. Since the procedure is over ten years old and engines have changed drastically, it might be advisable to re-evaluate the procedure as it applies to modern vehicles.

The demerit rating weighting system used in the CRC procedure (see Appendix B, Driveability Test Procedure) assigns weightings to malfunctions by the degree of severity. A trace hesitation, stumble or backfire is counted 6 demerits, moderate 12 and heavy 24 demerits. An engine stall when the vehicle is idling only counts 8 demerits and a stall while maneuvering 32. Since stalls are more serious from a safety standpoint and more irritating to the driver, it seems that the relative weighting of stalls should be increased in future programs.

Also, more work needs to be done on evaluating the relationship between the tolerance to driveability of the average customer in normal vehicle operation and ratings obtained by trained raters on a repetitive test procedure.

LIST OF REFERENCES

1. White, John T., III, "An Evaluation of Restorative Maintenance on Exhaust Emissions from In-Use Automobiles", Society of Automotive Engineers, Inc. No. 780082, March, 1978.

2. Coordinating Research Council, "Driveability Evaluation in Cool Weather", Report No. 439, December, 1970.

3. Coordinating Research Council - APRAC, "Study of the Interactions of Fuel Volatility and Automotive Design as They Relate to Driveability", No. CAPE 4-68 (2-68), April, 1972.

4. Coordinating Research Council - 1972 CRC Intermediate Temperature Driveability Program - Paso Robles, Report 483, December, 1975.

5. Coordinating Research Council - Driveability Performance of 1975 Passenger Cars at Intermediate Ambient Temperatures - Paso Robles, No. CM-102-74, May, 1976.

6. Coordinating Research Council - Driveability Performance of 1977 Passenger Cars at Intermediate Ambient Temperatures - Paso Robles, Report No. 499, September, 1978.

TABLE A-1 - APPENDIX A

BASELINE TUNE-UP SETTINGS

Model	Yr.	Cu. In. Disp.	Carb.	Odom.	Idle Setting Method	Speed Change	Idle Speed	Fast Idle Speed	Choke Setting	Basic Timing BTC
Volare	'77	225-F	1-Bbl.	11555	Propane	130 rpm	700-N	1700 (2nd)	.080 CI .110 Vac. Kick	2°
Granada	'77	302-C	2-VV	10202	Propane	40 rpm(1)	600-D	1900 (Hi)	Index	12°
Maverick	'77	250-F	1-Bbl.	11509	Propane	80 rpm	600-D	1700 (2nd)	1-R	6°
Pinto	'77	140-F	2-Bbl.	10241	Propane	70 rpm	800-D	2000 (2nd)	Index	20°
Chevelle	'77	305-F	2-Bbl.	15937	Idle Speed Drop	50 rpm	500-D	Pre-set	Index	8°
Skylark	'77	231-F	2-Bbl.	5914	Idle Speed Drop	40 rpm	600-D	Pre-set	1-R	12°
Century	'77	350-F	2-Bbl.	8822	Idle Speed Drop	60 rpm	600-D	1600 (Hi)	1-R	12°
Cutlass	'77	350-F	4-Bbl.	8097	Idle Speed Drop	30 rpm	550-D	900	2-R	20°
Cordoba	'77	400-F	4-Bbl.	6996	Propane	130 rpm	830-N	1400	.100"	20°
LTD II	'77	351-F	2-Bbl.	14457	Propane	120 rpm	625-D	2100 (Hi)	1-R	4°
Granada	'77	302-F	2-Bbl.	5379	Propane	80 rpm	650-D	2100	Index	2°
Volare	"77	318-F	2-Bbl.	8164	Propane	80 rpm	700-N	1400	.070 CI .110 Vac. Kick	8°

(1) Could not reach Specs.

TABLE A-1 - APPENDIX A

BASELINE TUNE-UP SETTINGS

	Yr.	Cu. In. Disp.	Carb.	Odom.	Idle Setting Method	Speed Change	Idle Speed	Fast Idle Speed	Choke Setting	Basic Timing BTC
Corolla	'78	97-F	2-Bbl.	3813	Idle Speed Drop	70 rpm	850-N	3200	Index	10°
Chevette	'77	98-F	1-Bbl.	20577	Idle Speed Drop	50 rpm	800-D	2400 (Hi)	3-R	8°
Volare	'77	318-C	2-Bbl.	25748	Idle CO (%)	0.5% CO	850-N	1500	Elect.	TDC
Maverick	'77	250-C	1-Bbl.	27800	Optimum Idle	"0" Increase	600-D	2100 (2nd)	2-R	8°
Grand Prix	'78	301-F	2-Bbl.	12524	Propane	30 rpm	550-D	2200 (Hi)	2-R	12°
Olds 98	'77	403-F	4-Bbl.	12079	Idle Speed Drop	30 rpm	550-D	900 (Lo)	2-R	20°
Concord	'78	258-C	2-Bbl.	1985	Idle Speed Drop	25 rpm	700-D	1600 (2nd)	Index	8°
Regal(2)	'78	231-F	4-Bbl.	8636	Lean Best Idle	20 rpm	650-D	2500 (Hi)	Index	15°
Sunbird	'78	151-C	2-Bbl.	33470	Propane	1% CO	650-D	2200	1-R	14°
Volvo 245-DL	'78	130-C	F.I.	2020	Idle CO	2.0% CO	900-N	900	None	12°

(2) Turbocharged

TABLE A-2

PERFORMANCE OF 1977 CHEVROLET CHEVETTE

1.6 LITER (98 CU. IN.) 1-BBL. FEDERAL CALIBRATION

	Base	Disconnect EGR Modification 1			Choke 1 Notch Rich Modification 2			Incr. Idle 125 rpm Modification 3			Choke 1 Notch Rich, Incr. Idle 125 rpm Modification 4		
			Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	109	89	-20	-18.3				97	-12	-11.0	71	-38	-34.9
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	14.2	13.7	-0.5	-3.5				13.7	-0.5	-3.5	14.3	+0.1	+0.7
Fuel Economy FTP 1/100 km (mpg)	9.89 (23.79)	9.84 (23.91)	-0.05 (+0.12)	-0.5 (+0.5)				10.50 (22.4)	+0.61 (-1.39)	+6.2 (-5.8)	10.75 (21.88)	+0.86 (-1.91)	+8.7 (-8.0)
Highway 1/100 km (mpg)	7.26 (32.39)	7.46 (31.55)	+0.2 (-0.84)	+2.8 (-2.6)				7.49 (31.42)	+0.23 (-0.97)	+3.2 (-3.0)	8.08 (29.11)	+0.82 (-3.28)	+11.3 (-10.1)
Emissions, HC, gm/km (gm/mi)	0.63 (1.02)	0.50 (0.81)	-0.13 (-0.21)	-20.6 (-20.6)				0.40 (0.65)	-0.23 (-0.37)	-36.3 (-36.3)	0.44 (0.71)	-0.19 (-0.31)	-30.4 (-30.4)
CO, gm/km (gm/mi)	9.77 (15.72)	7.70 (12.4)	-2.07 (-3.32)	-21.1 (-21.1)				8.28 (13.33)	-1.49 (-2.39)	-15.2 (-15.2)	7.97 (12.82)	-1.8 (-2.9)	-18.4 (-18.4)
NOx, gm/km (gm/mi)	1.12 (1.80)	3.06 (4.92)	+1.94 (+3.12)	+173 (+173)				1.27 (2.04)	+0.15 (+0.24)	+13.3 (+13.3)	1.27 (2.04)	+0.15 (+0.24)	+13.3 (+13.3)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-2-A

PERFORMANCE OF 1977 CHEVROLET CHEVETTE*

1.6 LITER (98 CU. IN.) 1-BBL. FEDERAL CALIBRATION

		Modification 1			Choke 1 Notch Rich Modification 2			Modification 3			Modification 4		
	Base*		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	109				62	-47	-43.1						
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	15.2				14.9	-0.3	-2.0						
Fuel Economy FTP 1/100 km (mpg)	10.64 (22.11)				10.19 (23.08)	-0.45 (+0.97)	-4.2 (+4.4)						
Highway 1/100 km (mpg)	7.69 (30.60)				7.42 (31.72)	-0.27 (+1.12)	-3.5 (+3.7)						
Emissions, HC, gm/km (gm/mi)	0.48 (0.78)				0.47 (0.76)	-0.01 (-0.02)	-2.6 (-2.6)						
CO, gm/km (gm/mi)	9.14 (14.69)				7.99 (12.86)	-1.15 (-1.83)	-12.5 (-12.5)						
NOx, gm/km (gm/mi)	1.22 (1.97)				1.19 (1.92)	-0.03 (-0.05)	-2.5 (-2.5)						

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

* Rebuilt trans. with old governor reinstalled.

TABLE A-3

PERFORMANCE OF 1977 CHEVROLET CHEVELLE

5.0 LITER (305 CU. IN.), 2-BBL. FEDERAL CALIBRATION

		Disconnect EGR Modification 1			Idle CO @ 3% Modification 2			Retard Spark 4° Modification 3			Retard Spark 4° Idle CO @ 3% Modification 4		
	Base		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	117	118	+1	+0.8	121	+4	+3.4	110	-7	-6.0	136	+19	+16.2
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	10.57	10.49	-0.08	-0.8	10.50	-0.07	-0.7	11.60	+1.03	+9.7	11.13	+0.56	+5.3
Fuel Economy													
FTP 1/100 km (mpg)	16.08 (14.64)	15.71 (14.98)	-0.37 (+0.34)	-2.3 (+2.3)	16.03 (14.68)	-0.05 (+0.04)	-0.3 (+0.3)	16.80 (14.00)	+0.72 (-0.64)	+4.5 (-4.4)	16.26 (14.47)	+0.18 (-0.17)	+1.1 (-1.2)
Highway 1/100 km (mpg)	12.6 (18.68)	11.85 (19.85)	-0.75 (+1.17)	-6.0 (+6.3)	12.0 (19.6)	-0.60 (+0.92)	-5.0 (+4.9)	13.22 (17.79)	+0.62 (-0.89)	+4.9 (-4.8)	12.02 (19.57)	-0.58 (+0.89)	-4.6 (+4.8)
Emissions,													
HC, gm/km (gm/mi)	0.63 (1.01)	0.71 (1.15)	+0.08 (+0.14)	+13.9 (+13.9)	1.42 (2.28)	+0.79 (+1.27)	+126 (+126)	0.70 (1.13)	+0.07 (+0.12)	+11.9 (+11.9)	1.41 (2.27)	+0.78 (+1.26)	+125 (+125)
CO, gm/km (gm/mi)	8.16 (13.14)	9.13 (14.69)	+0.97 (+1.55)	+11.8 (+11.8)	20.84 (33.53	+12.68 (+20.39)	+155 (+155)	11.76 (18.93)	+3.60 (+5.79)	+44.1 (+44.1)	23.95 (38.55)	+15.78 (+25.4)	+190 (+190)
NOx, gm/km (gm/mi)	1.69 (2.72)	2.31 (3.71)	+0.62 (+0.99)	+36.4 (+36.4)	1.73 (2.78)	+0.04 (+0.06)	+2.2 (+2.2)	1.24 (2.0)	-0.45 (-0.72)	-26.5 (-26.5)	1.56 (2.51)	-0.13 (-0.21)	-7.7 (-7.7)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-4

PERFORMANCE OF 1978 PONTIAC SUNBIRD

2.5 LITER (151 CU. IN.), 2-BBL., CALIFORNIA CALIBRATION

	Base	Disconnect O$_2$ Sensor Modification 1			Disconnect Mix Control Vac.Hose From Solenoid Modification 2			Disconnect EGR Modification 3			Combine 2 & 3 Modification 4		
			Δ 1	% 2		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2
CRC Driveability Demerits	117	99	-18	-15.4	89	-28	-23.9	105	-12	-10.3	103	-14	-12.0
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	14.9	14.5	-0.4	-2.7	14.5	-0.4	-2.7	14.6	-0.3	-2.0	14.2	-0.7	-4.7
Fuel Economy FTP 1/100 km (mpg)	10.88 (21.61)	12.71 (18.51)	+1.83 (-3.1)	+16.8 (-14.3)	12.60 (18.67)	+1.72 (-2.94)	+15.8 (-13.6)	10.92 (21.54)	+0.04 (-0.07)	+0.4 (-0.3)	12.84 (18.32)	+1.96 (-3.29)	+18.0 (-15.2)
Highway 1/100 km (mpg)	8.32 (28.28)	9.59 (24.52)	+1.27 (-3.76)	+15.3 (-13.3)	9.66 (24.35)	+1.34 (-3.93)	+16.1 (-13.9)	8.76 (26.85)	+0.44 (-1.43)	+5.3 (-5.1)	9.66 (24.36)	+1.34 (-3.92)	+16.1 (-13.9)
Emissions, HC, gm/km (gm/mi)	0.50 (0.81)	1.62 (2.61)	+1.12 (+1.8)	+222 (+222)	1.62 (2.61)	+1.12 (+1.8)	+222 (+222)	0.34 (0.55)	-0.16 (-0.26)	-32.1 (-32.1)	1.59 (2.56)	+1.09 (+1.75)	+216 (+216)
CO, gm/km (gm/mi)	5.44 (8.75)	60.37 (97.15)	+54.93 (+88.4)	+1010 (+1010)	57.83 (93.07)	+52.39 (+84.32)	+964 (+964)	4.84 (7.79)	-0.6 (-0.96)	-11.0 (-11.0)	61.09 (98.31)	+55.65 (+89.56)	+1024 (+1024)
NOx, gm/km (gm/mi)	1.21 (1.95)	0.41 (0.66)	-0.8 (-1.29)	-66.2 (-66.2)	0.39 (0.63)	-0.82 (-1.32)	-67.7 (-67.7)	1.17 (1.89)	-0.04 (-0.06)	-3.1 (-3.1)	0.44 (0.71)	-0.77 (-1.24)	-63.6 (-63.6)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-5

PERFORMANCE OF 1978 PONTIAC GRAND PRIX

4.9 LITER (301 CU. IN.) 2-BBL. FEDERAL CALIBRATION

		Disconnect EGR Modification 1			Idle CO @ 1.5% Modification 2			Idle CO @ 1.5% Disconnect EGR Modification 3			Vacuum Break +0.025" Modification 4		
	Base		Δ^1	%^{2}		Δ^1	%^{2}		Δ^1	%^{2}		Δ^1	%^{2}
CRC Driveability Demerits	55	77	+22	+40	67	+12	+22	60	+5	+9.1	59	+4	+7.3
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	9.84	9.79	-0.05	-0.5	9.88	+0.04	-0.4	9.48	-0.36	-3.7	9.76	-0.08	-0.8
Fuel Economy													
FTP 1/100 km (mpg)	14.30 (16.45)	14.47 (15.93)	+0.47 (-0.52)	+3.3 (-3.2)	14.21 (16.55)	-0.09 (+0.1)	-0.6 (+0.6)	14.12 (16.66)	-0.18 (+0.21)	-1.3 (+1.3)	14.48 (16.24)	+0.18 (-0.21)	+1.3 (-1.3)
Highway 1/100 km (mpg)	10.19 (23.09)	10.72 (21.94)	+0.53 (-1.15)	+5.2 (-5.0)	9.83 (23.93)	-0.36 (+0.84)	-3.5 (+3.6)	9.72 (24.24)	-0.47 (+1.12)	-4.6 (+4.9)	9.97 (23.59)	-0.22 (+0.5)	+2.2 (+2.2)
Emissions,													
HC, gm/km (gm/mi)	0.72 (1.16)	0.80 (1.29)	+0.08 (+0.13)	+11.2 (+11.2)	1.53 (2.46)	+0.81 (+1.3)	+112 (+112)	1.29 (2.27)	+0.57 (+0.91)	+78.4 (+78.4)	0.89 (1.43)	+0.17 (+0.27)	+23.3 (+23.3)
CO, gm/km (gm/mi)	5.72 (9.21)	5.69 (9.15)	-0.03 (-0.06)	-0.6 (-0.6)	14.37 (23.12)	+8.65 (+13.91)	+151 (+151)	16.34 (26.29)	+10.62 (+17.08)	+185 (+185)	5.95 (9.58)	+0.23 (+0.37)	+4.0 (+4.0)
NOx, gm/km (gm/mi)	1.03 (1.66)	3.24 (5.21)	+2.21 (+3.55)	+214 (+214)	1.08 (1.74)	+0.05 (+0.08)	+4.8 (+4.8)	2.81 (4.52)	+1.78 (+2.86)	+172 (+172)	1.28 (2.06)	+0.25 (+0.4)	+24.1 (+24.1)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-6

PERFORMANCE OF 1977 BUICK SKYLARK

3.8 LITER (231 CU. IN.), 2-BBL., FEDERAL CALIBRATION

		Disconnect EGR Modification 1			Choke 3 Notches Rich Modification 2			Disconnect EGR Choke 3 Notches Rich Modification 3			Incr. Idle 125 rpm Modification 4		
	Base		Δ 1	2		Δ 1	2		Δ 1	2		Δ 1	2
CRC Driveability Demerits	105	79	-26	-24.8	34	-71	-67.6	63	-42	-40	139	+34	+32.4
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	14.72	14.23	-0.49	-3.3	14.65	-0.07	-0.5	14.14	-0.58	-3.9	14.38	-0.34	-2.3
Fuel Economy													
FTP 1/100 km (mpg)	15.17 (15.51)	13.8 (17.06)	-1.37 (+1.55)	-9.0 (+10.0)	14.55 (16.17)	-0.62 (+0.66)	-4.1 (+4.3)	13.72 (17.15)	-1.45 (+1.64)	-9.6 (+10.6)	14.92 (15.77)	0.25 (+0.60)	-1.6 (+3.9)
Highway 1/100 km (mpg)	10.36 (22.70)	9.85 (23.88)	-0.51 (+1.18)	-4.9 (+5.2)	10.32 (22.78)	-0.04 (+0.08)	-0.4 (+0.4)	9.86 (23.86)	-0.5 (+1.16)	-4.8 (+5.1)	10.26 (22.92)	-0.1 (+0.22)	-1.0 +1.0
Emissions,													
HC, gm/km (gm/mi)	0.46 (0.74)	0.64 (1.03)	+0.18 (+0.29)	+39.2 (+39.2)	0.62 (1.0)	+0.16 (+0.26)	+35.1 (+35.1)	0.83 (1.34)	+0.37 (+0.60	+81.1 (+81.1)	0.44 (0.71)	-0.02 (-0.03)	-4.0 (-4.0)
CO, gm/km (gm/mi)	11.36 (18.27)	12.5 (20.11)	+1.14 (+1.84)	+10.1 (+10.1)	13.84 (22.26)	+2.48 (+3.99)	+21.8 (+21.8)	14.8 (23.9)	+3.50 (+5.63)	+30.8 (+30.8)	8.95 (14.40)	-2.40 (-3.87)	-21.2 (-21.2)
NOx gm/km (gm/mi)	1.03 (1.66)	3.07 (4.94)	+2.04 (+3.28)	+198 (+198)	0.95 (1.53)	-0.08 (-0.13)	-7.8 (-7.8)	2.96 (4.76)	+1.9 (+3.1)	+187 (+187)	1.15 (1.85)	+0.12 +0.19	+11.4 (+11.4)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-7

PERFORMANCE OF 1978 BUICK REGAL

3.8 LITER (231 CU. IN.) TURBOCHARGED, 4-BBL., FEDERAL CALIBRATION

	Base	Disconnect EGR Modification 1			Idle CO @ 2% Modification 2			Disconnect External Power Enrichment Modification 3			Special High Octane Fuel Modification 4		
			Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	91	82	-9	-9.9	75	-16	-17.6	46	-45	-49.5	103	+12	+13.2
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	10.07*	9.83*	-0.24	-2.4	10.26*	+0.19	+1.9	9.93*	-0.14	-1.4	9.11	-0.96	-9.5
Fuel Economy FTP 1/100 km (mpg)	14.51 (16.21)	15.56 (15.12)	+1.05 (-1.09)	+7.2 (-6.7)	15.69 (14.99)	+1.18 (-1.22)	+8.1 (-7.5)	16.73 (14.06)	+2.22 (-2.15)	+15.3 (-13.3)	14.44 (16.29)	-0.07 (+0.08)	-0.05 (+0.05)
Highway 1/100 km (mpg)	11.21 (20.98)	12.41 (18.96)	+1.02 (-2.02)	+10.7 (-9.6)	10.78 (21.81)	-0.43 (+0.83)	-3.8 (+4.0)	13.07 (17.99)	+1.86 (-2.99)	+16.6 (-14.3)	10.73 (21.92)	-0.48 (+0.94)	-4.3 (+4.4)
Emissions, HC, gm/km (gm/mi)	0.50 (0.81)	0.53 (0.86)	+0.03 (+0.05)	+6.2 (+6.2)	0.46 (0.74)	-0.04 (0.07)	-8.6 (-8.6)	1.41 (2.29)	+0.92 (+1.48)	+183 (+183)	0.62 (1.0)	+0.12 (+0.19)	+23.5 (+23.5)
CO, gm/km (gm/mi)	6.15 (9.90)	6.52 (10.49)	+0.37 (+0.59)	+6.0 (+6.0)	10.81 (17.4)	+1.66 (+7.5)	+75.8 (+75.8)	52.0 (83.7)	+45.85 (+73.78)	+745 (+745)	5.16 (8.3)	-0.99 (-1.6)	-16.2 (-16.2)
NOx, gm/km (gm/mi)	0.78 (1.26)	2.56 (4.12)	+1.78 (+2.86)	+227 (+227)	0.60 (0.97)	-0.18 (-0.29)	-23.0 (-23.0)	0.22 (0.35)	-0.56 (-0.91)	-72.2 (-72.2)	0.88 (1.41)	+0.1 (+0.15)	+11.9 (+11.9)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

* All accel. tests run on 91 RON nominal Sunlite Fuel

TABLE A-8

PERFORMANCE OF 1977 BUICK CENTURY

5.7 LITER (350 CU. IN.), 2-BBL., FEDERAL CALIBRATION

	Base	Disconnect EGR Modification 1			Idle CO @ 3% Modification 2			Idle Drop 20 rpm Modification 3			Disconnect EGR Idle Drop 20 rpm Modification 4		
			Δ [1]	% [2]		Δ [1]	% [2]		Δ [1]	% [2]		Δ [1]	% [2]
CRC Driveability Demerits	105	56	-49	-46.7	87	-18	-17.1	90	-15	-14.3	91	-14	-13.3
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	11.91	11.81	-0.1	-0.8	11.67	-0.24	-2.0	11.78	-0.13	-1.1	11.45	-0.46	-3.9
Fuel Economy FTP 1/100 km (mpg)	16.33 (14.41)	15.76 (14.94)	-0.57 (+0.53)	-3.5 (+3.7)	17.58 (13.38)	+1.25 (-1.03)	+7.7 (-7.1)	16.35 (14.39)	+0.02 (-0.02)	+0.1 (-0.1)	15.74 (14.95)	-0.59 (+0.54)	-3.6 (+3.7)
Highway 1/100 km (mpg)	11.88 (19.82)	11.39 (20.67)	-0.49 (+0.85)	-4.1 (+4.3)	12.18 (19.32)	+0.3 (-0.50)	+2.3 (-2.5)	11.53 (20.40)	-0.35 (+0.58)	-2.9 (+2.9)	11.35 (20.72)	-0.53 (+0.9)	-4.5 (+4.5)
Emissions, HC, gm/km (gm/mi)	0.51 (0.81)	0.50 (0.80)	-0.01 (-0.01)	-1.2 (-1.2)	1.75 (2.82)	+1.25 (+2.01)	+248 (+248)	1.19 (1.91)	+0.68 (+1.1)	+13.6 (+136)	1.32 (2.12)	+0.81 (+1.31)	+162 (+162)
CO, gm/km (gm/mi)	6.55 (10.53)	5.87 (9.44)	-0.68 (-1.09)	-10.4 (-10.4)	31.36 (50.46)	+24.79 (+39.9)	+379 (+379)	17.29 (27.83)	+10.75 (+17.3)	+164 (+164)	16.31 (26.25)	+9.76 (+15.7)	+149 (+149)
NOx, gm/km (gm/mi)	1.04 (1.67)	3.18 (5.11)	+2.14 (+3.44)	+206 (+206)	0.78 (1.26)	-0.25 (-0.41)	-24.6 (-24.6)	0.78 (1.25)	-0.26 (-0.42)	-2.5 (-2.5)	2.73 (4.4)	+1.70 (+2.73)	+163 (+163)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-9

PERFORMANCE OF 1977 OLDSMOBILE CUTLASS

5.7 LITER (350 CU. IN.), 4-BBL., FEDERAL CALIBRATION

		Disconnect EGR Modification 1			Choke 3 Notches Rich Modification 2			Choke 3 Notches Rich, Incr. Idle 125 rpm. Modification 3			Incr. Idle 125 rpm Modification 4		
	Base		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	127	84	-43	-33.9	77	-50	-39.4	85	-42	-33.1	71	-56	-44.1
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	10.14	10.00	-0.14	-1.4	9.90	-0.24	-2.4	9.82	-0.32	-3.2	10.01	-0.13	-1.3
Fuel Economy FTP 1/100 km (mpg)	16.12 (14.6)	16.0 (14.7)	-0.12 (+0.1)	-0.7 (+0.7)	16.38 (14.37)	+0.26 (-0.23)	+1.6 (-1.6)	17.16 (13.71)	+1.04 (-0.89)	+6.5 (-6.1)	17.20 (13.67)	+1.08 (-0.93)	+6.7 (-6.4)
Highway 1/100 km (mpg)	11.87 (19.83)	11.6 (20.36)	-0.27 (+0.53)	-2.3 (+2.7)	11.81 (19.91)	-0.06 (+0.08)	-0.5 (+0.4)	12.21 (19.27)	+0.34 (-0.56)	-2.9 (-2.8)	12.16 (19.34)	+0.29 (-0.49)	+2.4 (-2.5)
Emissions, HC, gm/km (gm/mi)	0.47 (0.75)	0.46 (0.74)	-0.01 (-0.01)	-1.3 (-1.3)	0.45 (0.73)	-0.02 (-0.02)	-2.7 (-2.7)	0.50 (0.81)	+0.04 (+0.06)	+8.0 (+8.0)	0.42 (0.68)	-0.04 (-0.07)	-9.3 (-9.3)
CO, gm/km (gm/mi)	4.73 (7.6)	4.12 (6.64)	-0.61 (-0.96)	-12.6 (-12.6)	5.92 (9.52)	+1.19 (+1.92)	+25.3 (+25.3)	7.31 (11.77)	+2.59 (+4.17)	+54.8 (+54.8)	4.68 (7.53)	-0.04 (-0.07)	-0.9 (-0.9)
NOx, gm/km (gm/mi)	1.25 (2.0)	4.7 (7.6)	+3.45 (+5.6)	+280 (+280)	1.19 (1.91)	-0.06 (-0.04)	-4.5 (-4.5)	1.66 (2.67)	+0.42 (+0.67)	+33.5 (+33.5)	1.45 (2.33)	+0.21 (+0.33)	+16.5 (+16.5)

---

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, +increase)

TABLE A-10

PERFORMANCE OF 1977 OLDSMOBILE 98

6.6 LITER (403 CU. IN.), 4-BBL. FEDERAL CALIBRATION

	Base	Disconnect EGR Modification 1			Choke 2 Notches Rich Modification 2			Fast Idle Plus 150 rpm Modification 3			Choke 2 Notches Rich Fast Idle + 150 rpm Modification 4		
			Δ 1	% 2		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2
CRC Driveability Demerits	84	93	+9	+10.7	61	-23	-27.4	88	+4	+4.8	39	-45	-53.6
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	9.72	9.67	-0.05	-0.5	9.82	+0.1	+1.0	9.72	0	0	9.88	+0.16	+1.6
Fuel Economy FTP 1/100 km (mpg)	16.49 (14.26)	16.55 (14.21)	+0.06 (-0.05)	+0.4 (-0.4)	16.29 (14.44)	-0.2 (+0.18)	-1.2 (+1.3)	16.06 (14.65)	-0.43 (+0.39)	-2.6 (+2.7)	16.32 (14.41)	-0.17 (+0.15)	-1.0 (+1.1)
Highway 1/100 km (mpg)	12.06 (19.50)	12.01 (19.58)	-0.05 (+0.08)	-0.4 (+0.4)	11.59 (20.29)	-0.47 (+0.79)	-3.9 (+4.1)	11.13 (21.13)	-0.93 (+1.63)	-7.7 (+8.4)	11.56 (20.35)	-0.5 (-0.85)	-4.1 (+4.4)
Emissions, HC, gm/km (gm/mi)	0.51 (0.82)	0.58 (0.93)	+0.07 (+0.11)	+13.4 (+13.4)	0.53 (0.85)	+0.02 (+0.03)	+3.7 (+3.7)	0.47 (0.75)	-0.04 (-0.07)	-8.5 (-8.5)	0.44 (0.71)	-0.07 (-0.11)	-13.4 (-13.4)
CO, gm/km (gm/mi)	4.65 (7.48)	4.51 (7.26)	-0.14 (-0.22)	-2.9 (-2.9)	5.31 (8.54)	+0.66 (+1.06)	+14.2 (+14.2)	3.80 (6.12)	-0.85 (-1.36)	-18.2 (-18.2)	4.84 (7.79)	+0.19 (+0.31)	+4.1 (+4.1)
NOx, gm/km (gm/mi)	1.59 (2.56)	5.16 (8.30)	+3.57 (+5.74)	+224 (+224)	1.40 (2.25)	-0.19 (-0.31)	-12.1 (-12.1)	1.28 (2.06)	-0.31 (-0.5)	-19.5 (-19.5)	1.21 (1.94)	-0.38 (-0.62)	-24.2 (-24.2)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-11

PERFORMANCE OF 1977 FORD PINTO

2.3 LITER (140 CU. IN.) 2-BBL. FEDERAL CALIBRATION

		Disconnect EGR Modification 1			Advance Timing 6° Modification 2			Idle CO @ 2% Modification 3			Idle CO @ 2% Incr. Idle 120 rpm Modification 4		
	Base		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2
CRC Driveability Demerits	154	152	-2	-1.3	115	-39	-25.3	93	-61	-39.6	137	-17	-11.0
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	14.0	13.2	-0.8	-5.7	12.5	-1.5	-10.7	13.1	-0.9	-6.4	13.2	-0.8	-5.7
Fuel Economy FTP 1/100 km (mpg)	12.7 (18.54)	12.0 (19.67)	-0.7 (+1.13)	-5.7 (+6.1)	11.67 (20.15)	-1.03 (+1.61)	-8.1 (+8.7)	12.21 (19.27)	-0.49 (+0.72)	-3.9 (+3.9)	12.51 (18.80)	-0.19 (+0.26)	-1.5 (+1.4)
Highway 1/100 km (mpg)	9.6 (24.46)	8.8 (26.60)	-0.8 (+2.14)	-8.0 (+8.8)	8.95 (26.27)	-0.65 (+1.81)	-6.8 (+7.4)	8.97 (26.22)	-0.63 (+1.76)	-6.6 (+7.2)	9.39 (25.06)	-0.21 (+0.60)	-2.2 (+2.5)
Emissions, HC, gm/km (gm/mi)	0.54 (0.87)	0.55 (0.89)	+0.01 (+0.02)	+2.3 (+2.3)	0.53 (0.86)	-0.01 (-0.01)	-1.1 (-1.1)	0.92 (1.48)	+0.38 (+0.61)	+70.1 (+70.1)	0.81 (1.30)	+0.27 (+0.43)	+49.4 (+49.4)
CO, gm/km (gm/mi)	9.48 (15.26)	10.04 (16.15)	+0.56 (+0.89)	+5.8 (+5.8)	7.70 (12.39)	-1.78 (-2.87)	-18.8 (-18.8)	18.08 (29.10)	+8.60 (+13.84)	+90.7 (+90.7)	16.77 (26.99)	+7.29 (+11.13)	+76.9 (+76.9)
NOx, gm/km (gm/mi)	0.90 (1.45)	2.57 (4.14)	+1.67 (+2.69)	+185.5 (+185.5)	1.19 (1.91)	+0.29 (+0.46)	+31.7 (+31.7)	0.89 (1.43)	-0.01 (-0.02)	-1.4 (-1.4)	0.86 (1.39)	-0.04 (-0.06)	-4.3 (-4.3)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-12

PERFORMANCE OF 1977 FORD MAVERICK

4.1 LITER (250 CU. IN.), 1-BBL - FEDERAL CALIBRATION

	Base	Disconnect EGR Modification 1			Advance Timing 6° Modification 2			Idle CO @ 1% Modification 3			Idle CO @ 1% Advance Timing 6° Modification 4		
			Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	160	128	-32	-20	97	-63	-39.4	145	-15	-9.4	152	-8	-5.0
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	12.9	12.6	-0.3	-2.3	12.3	-0.6	-4.7	12.1	-0.8	-6.2	12.3	-0.6	-4.7
Fuel Economy FTP 1/100 km (mpg)	13.9 (16.91)	13.7 (17.12)	-0.2 (+0.21)	-1.0 (+1.24)	13.29 (17.70)	-0.61 (+0.79)	-4.4 (+4.7)	13.60 (17.29)	-0.30 (+0.38)	-2.2 (+2.2)	13.93 (16.88)	+0.03 (-0.03)	+0.2 (-0.2)
Highway 1/100 km (mpg)	10.6 (22.20)	10.8 (21.72)	+0.2 (-0.48)	+2.2 (-2.16)	10.33 (22.76)	-0.27 (+0.56)	-2.5 (+2.5)	10.27 (22.90)	-0.33 (+0.70)	-3.1 (+3.2)	10.64 (22.10)	+0.04 (-0.10)	+0.4 (-0.5)
Emissions, HC, gm/km (gm/mi)	1.09 (1.75)	0.82 (1.32)	-0.27 (0.43)	-25.6 (-25.6)	1.09 (1.75)	0 (0)	0 (0)	1.54 (2.48)	+0.46 (+4.73)	+41.7 (+41.7)	1.78 (2.86)	+0.69 (+1.11)	+63.4 (+63.4)
CO, gm/km (gm/mi)	8.02 (12.91)	8.15 (13.11)	+0.13 (+0.20)	+1.55 (+1.55)	7.71 (12.40)	-0.31 (-0.51)	-4.0 (-4.0)	13.41 (21.57)	+5.39 (+8.66)	+67.2 (+67.1)	13.54 (21.79)	+5.52 (+8.88)	+68.8 (+68.8)
NOx, gm/km (gm/mi)	0.90 (1.45)	4.77 (7.68)	+3.87 (+6.23)	+430 (+430)	1.19 (1.91)	+0.29 (+0.46)	31.7 (+31.7)	0.93 (1.50)	+0.03 (+0.05)	+3.4 (+3.4)	1.07 (1.73)	+0.17 (+0.28)	+19.3 (+19.3)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-13

PERFORMANCE OF 1977 FORD MAVERICK

4.1 LITER (250 CU. IN.), 1-BBL. CALIFORNIA CALIBRATION

		Disconnect EGR Modification 1			Choke 2 Notches Lean Modification 2			Disconnect EGR Choke 2 Notches Lean Modification 3			Idle CO @ 0.3% Modification 4 **		
	Base *		Δ [1]	% [2]		Δ [1]	% [2]		Δ [1]	% [2]		Δ [1]	% [2]
CRC Driveability Demerits	115	51	-64	-55.7	53	-62	-53.9	47	-68	-59.1	-	-	-
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	15.5	15.0	-0.5	-3.2	15.6	+0.1	+0.6	15.4	-0.1	-0.6	15.45	-0.05	-0.3
Fuel Economy FTP 1/100 km (mpg)	16.18 (14.54)	15.03 (15.65)	-1.15 (+1.11)	-7.1 (+7.6)	16.12 (14.59)	-0.06 (+0.05)	-0.4 (+0.3)	15.22 (15.45)	-0.96 (+0.91)	-5.9 (+6.3)	16.12 (14.59)	-0.06 (+0.05)	-0.4 (+0.3)
Highway 1/100 km (mpg)	12.94 (18.17)	11.97 (19.65)	-0.97 (+1.48)	-7.5 (+8.1)	12.85 (18.30)	-0.09 (+0.13)	-0.7 (+0.7)	11.81 (19.91)	-1.13 (+1.74)	-8.7 (+9.6)	13.05 (18.02)	+0.11 (-0.15)	+0.01 (-0.01)
Emissions, HC, gm/km (gm/mi)	0.55 (0.89)	0.46 (0.74)	-0.09 (-0.15)	-16.9 (-16.9)	0.49 (0.79)	-0.06 (-0.1)	-11.2 (-11.2)	0.43 (0.70)	-0.12 (-0.19)	-21.3 (-21.3)	0.55 (0.88)	0 (-0.01)	0 (-0.01)
CO, gm/km (gm/mi)	7.37 (11.86)	5.29 (8.52)	-2.08 (-3.34)	-28.2 (-28.2)	5.64 (9.07)	-1.73 (-2.79)	-23.5 (-23.5)	7.57 (12.18)	+0.20 (+0.32)	+2.7 (+2.7)	11.43 (18.40)	+4.06 (+6.54)	+55.1 (+55.1)
NOx, gm/km (gm/mi)	0.80 (1.28)	4.09 (6.58)	+3.29 (+5.3)	+414 (+414)	0.78 (1.25)	-0.02 (-0.03)	-2.3 (-2.3)	2.38 (3.83)	+1.58 (+2.55)	+199 (+199)	(0.62) (1.00)	(-0.18) (-0.28)	(-22.5) (-22.0)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

* Idle CO @ 3.2% w/o exhaust manifold air injection.

** Single run.

TABLE A-14

PERFORMANCE OF 1977 FORD GRANADA

4.9 LITER (302 CU. IN.) 2-BBL. FEDERAL CALIBRATION

		Disconnect EGR			Choke 3 Notches Rich			Idle CO @ 2%			Idle CO @ 2% Retard Timing 4°		
	Base	Modification 1	Δ[1]	%[2]	Modification 2	Δ[1]	%[2]	Modification 3	Δ[1]	%[2]	Modification 4	Δ[1]	%[2]
CRC Driveability Demerits	83	48	-35	-42.2	47	-36	-43.4	123	+40	+48.2	86	+3	+3.6
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	11.07	10.91	-0.16	-1.4	11.18	-0.11	-1.0	11.31	+0.24	+2.2	11.80	+0.73	+6.6
Fuel Economy FTP 1/100 km (mpg)	16.54 (14.22)	16.72 (14.07)	+0.18 (-0.15)	+0.1 (-0.1)	16.85 (13.96)	+0.31 (-0.26)	+1.9 (-1.8)	16.99 (13.84)	+0.45 (-0.38)	+2.7 (-2.7)	17.98 (13.08)	+1.44 (-1.14)	+8.7 (-8.0)
Highway 1/100 km (mpg)	12.26 (19.19)	12.85 (18.31)	+0.59 (-0.88)	+4.8 (-4.6)	12.43 (18.92)	+0.17 (-0.27)	+1.4 (-1.4)	12.64 (18.61)	+0.38 (0.58)	+3.1 (-3.0)	13.36 (17.61)	+1.10 (-1.58)	+9.0 (-8.2)
Emissions, HC, gm/km (gm/mi)	1.14 (1.84)	1.01 (1.63)	-0.13 (-0.21)	-11.4 (-11.4)	1.17 (1.88)	+0.03 (+0.04)	+2.2 (+2.2)	0.78 (1.26)	-0.36 (-0.58)	-31.5 (-31.5)	0.77 (1.24)	-0.37 (-0.60)	-32.6 (-32.6)
CO, gm/km (gm/mi)	4.62 (7.43)	4.76 (7.65)	+0.14 (+0.22)	+3.0 (+3.0)	4.89 (7.87)	+0.27 (+0.44)	+5.9 (+5.9)	5.26 (8.47)	+0.64 (+1.04)	+14.0 (+14.0)	6.65 (10.7)	+2.03 (+3.27)	+44.0 (+44.0)
NOx, gm/km (gm/mi)	1.27 (2.03)	4.45 (7.15)	+3.18 (+5.12)	+252 (+252)	1.39 (2.23)	+0.12 (+0.20)	+9.9 (+9.9)	0.98 (1.58)	-0.29 (-0.45)	-22.2 (-22.2)	0.91 (1.47)	-0.36 (-0.56)	-27.6 (-27.6)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-15

PERFORMANCE OF 1977 FORD GRANADA

4.9 LITER (302 CU. IN.), 2-BBL., VARIABLE VENTURI - CALIFORNIA CALIBRATION

		Disconnect EGR Modification 1			Retard Timing 4° Modification 2			Idle CO @ 2% Modification 3			Idle CO @ 2% Decrease Idle 50 rpm Modification 4		
	Base		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2
CRC Driveability Demerits	150	4	-146	-97.3	45	-105	-70.0	63	-87	-58	35	-115	-76.7
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	11.4	11.6	+0.2	+1.8	13.0	+1.6	+14.0	11.2	-0.2	-1.8	11.4	0	0
Fuel Economy FTP 1/100 km (mpg)	19.3 (12.18)	18.0 (13.05)	-1.3 (+0.87)	-6.7 (+7.1)	20.52 (11.46)	+1.22 (-0.72)	+6.3 (-5.9)	18.92 (12.43)	-0.38 (+0.25)	-2.0 (+2.1)	18.62 (12.63)	-0.68 (+0.45)	-3.5 (+3.7)
Highway 1/100 km (mpg)	13.5 (17.46)	12.9 (18.28)	-0.6 (+0.82)	-4.4 (+4.7)	14.25 (16.51)	+0.75 (-0.95)	+5.6 (-5.4)	13.08 (17.98)	-0.42 (+0.52)	-3.1 (+3.0)	13.68 (17.19)	+0.18 (-0.27)	+1.3 (-1.5)
Emissions, HC, gm/km (gm/mi)	0.46 (0.74)	0.58 (0.93)	+0.12 (+0.19)	+25.7 (+25.7)	0.43 (0.70)	-0.03 (-0.04)	-5.4 (-5.4)	0.45 (0.73)	-0.01 (-0.01)	-1.4 (-1.4)	0.45 (0.72)	-0.01 (-0.02)	-2.7 (-2.7)
CO, gm/km (gm/mi)	3.04 (4.90)	2.35 (3.79)	-0.69 (-1.11)	-22.7 (-22.7)	2.85 (4.58)	-0.19 (-0.32)	-6.5 (-6.5)	2.72 (4.38)	-0.32 (-0.52)	-10.6 (-10.6)	2.65 (4.26)	-0.30 (-0.64)	-13.1 (-13.1)
NOx, gm/km (gm/mi)	0.70 (1.12)	2.13 (3.43)	+1.43 (+2.31)	+206.3 (+206.3)	0.69 (1.10)	-0.01 (-0.02)	-1.8 (-1.8)	0.65 (1.04)	-0.05 (-0.08)	-7.1 (-7.1)	0.63 (1.02)	-0.07 (-0.10)	-10.0 (-10.0)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-16

PERFORMANCE OF 1977 FORD LTD II

5.8 LITER (351 CU. IN.) 2-BBL., FEDERAL CALIBRATION

	Base	Disconnect EGR			Advance Timing 4°			Dec. Idle 100 rpm			Advance Timing 4° Dec. Idle 75 rpm (3)		
		Modification 1			Modification 2			Modification 3			Modification 4		
			Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	211	126	-85	-40.3	237	+26	+12.3	243	+32	+15.2	223	+12	+5.7
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	10.4	10.45	+0.05	+0.5	10.08	-0.32	-3.1	10.42	+0.02	+0.2	10.14	-0.26	-2.5
Fuel Economy													
FTP 1/100 km (mpg)	17.07 (13.79)	17.34 (13.57)	+0.27 (-0.22)	+1.6 (-1.6)	17.44 (13.49)	+0.37 (-0.30)	+2.2 (-2.2)	17.53 (13.42)	+0.46 (-0.37)	+2.7 (-2.7)	17.50 (13.44)	+0.43 (-0.35)	+2.5 (-2.5)
Highway 1/100 km (mpg)	12.25 (19.21)	12.6 (18.7)	+0.35 (-0.51)	+2.9 (-2.7)	12.81 (18.36)	+0.56 (-0.85)	+4.6 (-4.4)	13.30 (17.68)	+1.05 (-1.53)	+8.6 (-8.0)	13.18 (17.85)	+0.93 (-1.36)	+7.6 (-7.1)
Emissions,													
HC, gm/km (gm/mi)	0.79 (1.27)	0.75 (1.20)	-0.04 (-0.07)	-5.5 (-5.5)	0.75 (1.21)	-0.04 (-0.06)	-4.7 (-4.7)	0.87 (1.40)	+0.08 (+0.13)	+10.2 (+10.2)	0.91 (1.46)	+0.12 (-0.19)	+15.0 (+15.0)
CO, gm/km (gm/mi)	6.42 (10.32)	6.64 (10.67)	+0.22 (+0.35)	+3.4 (+3.4)	6.38 (10.27)	-0.04 (-0.05)	-0.5 (-0.5)	8.87 (14.27)	+2.45 (+3.95)	+38.3 (+38.3)	8.43 (13.56)	+2.01 (+3.24)	+31.4 (+31.4)
NOx, gm/km (gm/mi)	1.5 (2.42)	5.24 (8.42)	+3.74 (+6.0)	+248 (+248)	1.75 (2.81)	+0.25 (+0.39)	+16.1 (+16.1)	1.22 (1.97)	-0.28 (-0.45)	-18.6 (-18.6)	1.78 (2.87)	+0.28 (+0.45)	+18.6 (+18.6)

[1] Difference between value for respective modification and base (-decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

[3] EPa originally specified a 100 to 150 rpm reduction in idle speed; however, a 75 rpm reduction was the largest reduction possible to maintain a stall-free idle.

TABLE A-17

PERFORMANCE OF 1977 PLYMOUTH VOLARE

3.7 LITER (225 CU. IN.), 1-BBL., FEDERAL CALIBRATION

	Base	Disconnect EGR Modification 1			Advance Timing 6° Modification 2			Idle CO @ 4% Modification 3			Incr. Idle 120 rpm Idle CO @ 4% Modification 4		
			Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	238	156	-82	-34.5	211	-27	-11.3	363	+125	+52.5	353	+115	+48.3
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	14.4	13.9	-0.5	-3.5	14.1	-0.3	-2.1	14.0	-0.4	-2.8	14.5	+0.1	+0.7
Fuel Economy FTP 1/100 km (mpg)	14.4 (16.32)	13.0 (18.07)	-1.4 (+1.75)	-9.7 (+10.7)	13.48 (17.45)	-0.92 (+1.13)	-6.4 (+6.9)	13.80 (17.04)	-0.6 (+0.72)	-4.2 (+4.4)	14.45 (16.28)	+0.05 (-0.04)	+0.3 (-0.2)
Highway 1/100 km (mpg)	11.1 (21.21)	9.9 (23.78)	-1.2 (+2.57)	-10.8 (+12.1)	10.47 (22.47)	-0.63 (+1.26	-5.7 (+5.9)	10.55 (22.29)	-0.55 (+1.08)	-5.0 (+5.1)	10.79 (21.79)	-0.31 (+0.58)	-2.8 (+2.7)
Emissions,													
HC, gm/km (gm/mi)	0.83 (1.34)	0.90 (1.45)	+0.07 (+0.11)	+8.2 (+8.2)	0.75 (1.21)	-0.08 (-0.13)	-9.7 (-9.7)	1.26 (2.02)	+0.43 (+0.68)	+50.7 (+50.7)	1.29 (2.07)	+0.46 (+0.73)	+54.5 (+54.5)
CO, gm/km (gm/mi)	6.76 (10.88)	7.18 (11.56)	+0.42 (+0.68)	+6.3 (+6.3)	5.76 (9.27)	-1.0 (-1.61)	-14.8 (-14.8)	12.53 (20.17)	+5.77 (+9.29)	+85.4 (+85.4)	15.52 (24.98)	+8.76 (+14.1)	+129.6 (+129.6)
NOx, gm/km (gm/mi)	1.12 (1.80)	3.94 (6.34)	+2.82 (4.54)	+252.2 (+252.2)	1.21 (1.95)	+0.9 (+0.15)	+8.3 (+8.3)	1.03 (1.66)	-0.09 (-0.14)	-7.8 (-7.8)	0.98 (1.57)	-0.14 (-0.23)	-12.8 (-12.8)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-18

PERFORMANCE OF 1977 PLYMOUTH VOLARE

5.2 LITER (318 CU.IN.) 2-BBL., FEDERAL CALIBRATION

		Disconnect EGR Modification 1			Incr. Idle 250 rpm Modification 2			Idle CO @ 1% Modification 3			Idle CO @ 1% Incr. Idle 250 rpm Modification 4		
	Base		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2
CRC Driveability Demerits	244	195	-49	-20.1	226	-18	-7.4	251	+7	+2.9	234	-10	-4.1
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	10.05	9.83	-0.22	-2.2	10.05	0	0	10.02	-0.03	-0.3	9.97	-0.08	-0.8
Fuel Economy													
FTP 1/100 km (mpg)	18.62 (12.65)	17.44 (13.49)	-1.18 (+0.84)	-6.3 (+6.6)	19.72 (11.93)	+1.1 (-0.72)	+5.9 (-5.7)	19.41 (12.12)	+0.79 (-0.53)	+4.2 (-4.2)	20.22 (11.63)	+1.6 (-1.02)	+8.6 (-8.1)
Highway 1/100 km (mpg)	13.24 (17.79)	12.56 (18.73)	-0.68 (+0.94)	-5.1 (+5.3)	13.52 (17.4)	+0.28 (-0.39)	+2.1 (-2.2)	13.46 (17.47)	+0.22 (-0.32)	+1.7 -1.8	13.60 (17.3)	+0.36 (-0.49)	+2.7 (-2.8)
Emissions,													
HC, gm/km (gm/mi)	0.63 (1.02)	0.55 (0.89)	-0.08 (-0.13)	-12.7 (-12.7)	0.57 (0.92)	-0.06 (-0.1)	-9.8 (-9.8)	0.93 (1.49)	+0.3 (+0.47)	+46.1 (+46.1)	0.87 (1.4)	+0.24 (+0.38)	+37.3 (+37.3)
CO, gm/km (gm/mi)	7.23 (11.63)	7.73 (12.43)	+0.5 (+0.8)	+6.9 (+6.9)	9.03 (14.53)	+1.8 (+2.9)	+24.9 (+24.9)	14.25 (22.74)	+7.02 (+11.31)	+97.2 (+97.2)	15.25 (24.54)	+8.02 (12.91)	+111 (+111)
NOx, gm/km (gm/mi)	0.89 (1.43)	1.65 (2.65)	+0.77 (+1.22)	+85 (+85)	0.93 (1.49)	+0.04 (+0.06)	+4.2 (+4.2)	0.96 (1.55)	+0.07 (+0.12)	+8.4 (+8.4)	1.00 (1.61)	+0.11 (+0.18)	+12.6 (+12.6)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-19

PERFORMANCE OF 1977 PLYMOUTH VOLARE

5.2 LITER (318 CU. IN.) 2-BBL. - CALIFORNIA CALIBRATION

		Disconnect EGR Modification 1			Disconnect Choke Heater Modification 2			Idle CO @ 2% Modification 3			Idle CO @ 2% Retard timing 5° Modification 4		
	Base		Δ [1]	% [2]		Δ [1]	% [2]		Δ [1]	% [2]		Δ [1]	% [2]
CRC Driveability Demerits	269	136	-133	-49.4	259	-10	-3.7	211	-58	-21.6	308	+39	+14.5
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	11.8	11.8	0	0	11.6	-0.2	-1.7	11.8	0	0	12.9	+1.1	+9.3
Fuel Economy FTP 1/100 km (mpg)	22.25 (10.57)	20.17 (11.66)	-2.08 (+1.09)	-93 (+10.3)	21.50 (10.94)	-0.75 (+0.37)	-3.4 (+3.5)	21.50 (10.94)	-0.75 (+0.37)	-3.4 (+3.5)	23.90 (9.84)	+1.65 (-0.73)	+7.4 (-6.9)
Highway 1/100 km (mpg)	15.19 (15.48)	13.07 (17.99)	-2.12 (+2.51)	-14.0 (+16.2)	15.10 (15.58)	-0.09 (+0.10)	-0.6 (+0.6)	15.09 (15.59)	-0.10 (+0.11)	-0.7 (+0.7)	16.22 (14.5)	+1.03 (-0.95)	+6.8 (-6.3)
Emissions, HC, gm/km (gm/mi)	0.29 (0.47)	0.22 (0.36)	-0.07 (-0.11)	-23.4 (-23.4)	0.23 (0.37)	-0.06 (-0.1)	-21.3 (-21.3)	0.34 (0.55)	+0.05 (+0.08)	+17.0 (+17.0)	0.36 (0.58)	+0.07 (+0.11)	+23.4 (+23.4)
CO, gm/km (gm/mi)	2.06 (3.32)	1.63 (2.63)	-0.43 (-0.69)	-20.8 (-20.8)	1.93 (3.11)	-0.13 (-0.21)	-6.3 (-6.3)	2.21 (3.55)	+0.15 (+0.23)	+6.9 (+6.9)	4.82 (7.75)	+2.76 (+4.43)	+133 (+133)
NOx, gm/km (gm/mi)	1.17 (1.88)	1.86 (3.0)	+0.69 (+1.12)	+59.6 (+59.6)	1.01 (1.63)	-0.16 (-0.25)	-13.3 (-13.3)	1.04 (1.67)	-0.13 (-0.21)	-11.2 (-11.2)	1.01 (1.63)	-0.16 (0.25)	-13.3 (-13.3)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-20

PERFORMANCE OF 1977 CHRYSLER CORDOBA

6.6 LITER (400 CU. IN.), 4-BBL. CARB., LEAN BURN, FEDERAL CALIBRATION

	Base	Disconnect Electric Choke Modification 1			Advance Timing 4° Modification 2			Idle CO @ .75% Modification 3			Idle CO @ .75% Incr. Idle 125 rpm Modification 4		
			Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	185	165	-20	-10.8	177	-8	-4.3	213	+28	+15.1	193	8	+4.3
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	9.7	9.86	+0.16	+1.6	9.12	-0.58	-6.0	9.85	+0.15	+1.5	9.67	-0.03	-0.3
Fuel Economy FTP 1/100 km (mpg)	20.7 (11.36)	21.83 (10.78)	+1.13 (-0.58)	+5.5 (-5.1)	21.21 (11.09)	+0.51 (-0.27)	+2.5 (-2.4)	21.52 (10.93)	+0.82 (-0.43)	+4.0 (-3.8)	22.21 (10.59)	+1.51 (-0.77)	+7.3 (-6.8)
Highway 1/100 km (mpg)	13.63 (17.26)	13.88 (16.95)	+0.25 (-0.31)	+1.8 (-1.8)	13.30 (17.68)	-0.33 (+0.42)	-2.4 (+2.4)	13.29 (17.7)	-0.34 (+0.44)	-2.5 (+2.5)	14.24 (16.52)	+0.61 (-0.74)	+4.5 (-4.3)
Emissions, HC, gm/km (gm/mi)	0.42 (0.68)	0.40 (0.65)	-0.02 (-0.03)	-4.4 (-4.4)	0.45 (0.72)	+0.03 (+0.04)	+5.9 (+5.9)	0.98 (1.57)	+0.56 (+0.89)	+131 (+131)	1.01 (1.63)	+0.59 (+0.95)	+140 (+140)
CO, gm/km (gm/mi)	3.63 (5.83)	5.23 (8.42)	+1.6 (+2.59)	+44.[illegible] (+44.[illegible])	3.88 (6.24)	+0.25 (-0.41)	+7.0 (+7.0)	18.00 (28.97)	+14.37 (+23.14)	+397 (+397)	21.31 (34.3)	+17.68 (+28.47)	+488 (+488)
NOx, gm/km (gm/mi)	1.07 (1.72)	1.18 (1.90)	+0.11 (+0.18)	+10.5 (+10.5)	1.26 (2.03)	+0.19 (+0.31)	+18.0 (+18.0)	1.06 (1.70)	-0.01 (-0.02)	-1.2 (-1.2)	1.20 (1.93)	+0.13 (+0.21)	+12.2 (+12.2)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-21

PERFORMANCE OF 1978 AMC CONCORD

4.2 LITER (258 CU. IN.), 1-BBL., CALIFORNIA CALIBRATION

		Disconnect EGR Modification 1			Retard Spark 3° Modification 2			Idle CO @ 2% Modification 3			Idle CO @ 2% Choke 2 Notches Rich Modification 4		
	Base		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	121	34	-87	-71.9	165	+44	+36.4	127	+6	+5.0	106	-15	-12.4
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	17.43	12.78	-4.65	-26.7	18.4	+0.97	+5.6	16.88	-0.55	-3.2	17.98	+0.55	+3.2
Fuel Economy FTP 1/100 km (mpg)	17.83 (13.19)	15.41 (15.26)	-2.42 (2.07)	-13.6 (+15.7)	19.65 (11.97)	+1.82 (-1.22)	+10.2 (-9.2)	17.79 (13.22)	-0.04 (+0.03)	-0.2 (+0.2)	17.01 (13.83)	-0.82 (+0.64)	-4.6 (+4.9)
Highway 1/100 km (mpg)	15.00 (15.68)	11.68 (20.14)	-3.32 (+4.46)	-22.1 (+28.4)	15.94 (14.76)	+0.94 (-0.92)	+6.3 (-5.9)	14.49 (16.23)	-0.51 (+0.55)	-3.4 (+3.5)	14.32 (16.43)	-0.68 (+0.75)	-4.5 (+4.8)
Emissions, HC, gm/km (gm/mi)	0.19 (0.31)	0.14 (0.23)	-0.05 (-0.08)	-25.8 (-25.8)	0.21 (0.33)	+0.02 (+0.02)	+6.5 (+6.5)	0.19 (0.30)	0 (-0.01)	-3.2 (-3.2)	0.27 (0.43)	+0.08 (+0.12)	+38.7 (+38.7)
CO, gm/km (gm/mi)	3.46 (5.57)	1.92 (3.09)	-1.54 (-2.48)	-44.5 (-44.5)	5.59 (9.00)	+2.13 (+3.43)	+61.6 (+61.6)	3.47 (5.59)	+0.01 (+0.02)	+0.4 (+0.4)	6.34 (10.21)	+2.88 (+4.64)	+83.3 (+83.3)
NOx, gm/km (gm/mi)	0.69 (1.11)	2.63 (4.23)	+1.94 (+3.12)	+281 (+281)	0.60 (0.96)	-0.09 (-0.15)	-13.5 (-13.5)	0.60 (0.97)	-0.09 (-0.14)	-12.6 (-12.6)	0.54 (0.87)	-0.15 (-0.24)	-21.6 (-21.6)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-22

PERFORMANCE OF 1978 TOYOTA COROLLA

1.6 LITER (97 CU. IN.), 2-BBL. FEDERAL CALIBRATION

		Retard Spark 4° Modification 1			Dec. Fast Idle 200 rpm Modification 2			Idle CO @ 1% Modification 3			Dec. Fast Idle 200 rpm Idle CO @ 1% Modification 4		
	Base		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	12	12	0	0	6	-6	-50	14	+2	+16.7	0	-12	-100
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	13.0	13.4	+0.4	+3.1	12.8	-0.2	-1.5	13.1	+0.1	+0.8	13.0	0	0
Fuel Economy													
FTP 1/100 km (mpg)	10.65 (22.09)	10.31 (22.81)	-0.34 (+0.72)	-3.2 (+3.3)	9.96 (23.61)	-0.69 (+1.52)	-6.5 (+6.9)	10.83 (21.71)	+0.18 (-0.38)	+1.7 (-1.7)	10.53 (22.33)	-0.12 (+0.24)	-1.1 (+1.1)
Highway 1/100 km (mpg)	8.52 (27.62)	8.49 (27.72)	-0.03 (+0.1)	-0.4 (+0.4)	8.48 (27.75)	-0.04 (+0.13)	-0.5 (+0.5)	8.95 (26.29)	+0.43 (-1.33)	+5.0 (-4.8)	8.58 (27.41)	+0.06 (-0.21)	+0.7 (-0.8)
Emissions,													
HC, gm/km (gm/mi)	0.45 (0.72)	0.42 (0.67)	-0.03 (-0.05)	-6.9 (-6.9)	0.42 (0.67)	-0.03 (-0.05)	-6.9 (-6.9)	0.46 (0.74)	+0.01 (+0.02)	+2.8 (+2.8)	0.49 (0.79)	+0.04 (+0.07)	+9.7 (+9.7)
CO, gm/km (gm/mi)	6.19 (9.96)	6.04 (9.72)	-0.15 (-0.24)	-2.4 (-2.4)	4.98 (8.02)	-1.21 (-1.94)	-19.5 (-19.5)	8.25 (13.28)	+2.06 (+3.32)	+33.3 (+33.3)	8.12 (13.06)	+1.93 (+3.1)	+31.1 (+31.1)
NOx, gm/km (gm/mi)	1.15 (1.85)	0.99 (1.59)	-0.16 (-0.26)	-14.1 (-14.1)	1.30 (2.10)	+0.15 (+0.25)	+13.5 (+13.5)	1.09 (1.76)	-0.06 (-0.09)	-4.9 (-4.9)	1.00 (1.61)	-0.15 (-0.24)	-13.0 (-13.0)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-23

PERFORMANCE OF 1978 VOLVO 245-DL

2.1 LITER (130 CU. IN.) FUEL INJECTION - CALIFORNIA CALIBRATION

	Base	Disconnect O_2 Sensor Modification 1			Adv. Ignition Timing 5° Modification 2			Idle CO @ 4% Modification 3			Combine 1, 2, 3 Modification 4		
			Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	17	16	-1	-5.9	23	+6	+35.3	26	+9	+52.9	18	+1	+5.9
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	14.0	14.2	+0.2	+1.4	13.8	-0.2	-1.4	14.3	+0.3	+2.1	13.7	-0.3	-2.1
Fuel Economy													
FTP 1/100 km (mpg)	12.58 (18.70)	12.85 (18.31)	+0.27 (-0.39)	+2.1 (-2.1)	12.65 (18.59)	+0.07 (-0.11)	+0.6 (-0.6)	12.85 (18.31)	+0.27 (-0.39)	+2.1 (-2.1)	12.99 (18.10)	+0.41 (-0.6)	+3.3 (-3.2)
Highway 1/100 km (mpg)	9.27 (25.36)	9.75 (24.12)	+0.48 (-1.24)	+5.2 (-4.9)	9.85 (23.89)	+0.58 (-1.47)	+6.3 (-5.8)	9.79 (24.02)	+0.52 (-1.34)	+5.6 (-5.3)	9.89 (23.79)	+0.62 (-1.57)	+6.7 (-6.2)
Emissions,													
HC, gm/km (gm/mi)	0.20 (0.32)	0.32 (0.51)	+0.12 (+0.19)	+59.4 (+59.4)	0.19 (0.30)	-0.01 (-0.02)	-6.3 (-6.3)	0.19 (0.31)	-0.01 (-0.01)	-3.1 (-3.1)	1.06 (1.70)	+0.86 (+1.38)	+431 (+431)
CO, gm/km (gm/mi)	2.04 (3.28)	5.97 (9.60)	+3.93 (+6.32)	+193 (+193)	2.39 (3.84)	+0.35 (+0.56)	+17.1 (+17.1)	2.42 (3.90)	+0.38 (+0.62)	+18.9 (+18.9)	26.70 (42.97)	+24.66 (+39.69)	+1210 (+1210)
NOx, gm/km (gm/mi)	0.42 (0.67)	1.02 (1.64)	+0.6 (+0.97)	+145 (+145)	0.47 (0.76)	+0.05 (+0.09)	+13.4 (+13.4)	0.59 (0.95)	+0.17 (+0.28)	+41.8 (+41.8)	0.43 (0.70)	+0.01 (+0.03)	+4.5 (+4.5)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-22

PERFORMANCE OF 1978 TOYOTA COROLLA

1.6 LITER (97 CU. IN.), 2-BBL. FEDERAL CALIBRATION

		Retard Spark 4° Modification 1			Dec. Fast Idle 200 rpm Modification 2			Idle CO @ 1% Modification 3			Dec. Fast Idle 200 rpm Idle CO @ 1% Modification 4		
	Base		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2		Δ 1	% 2
CRC Driveability Demerits	12	12	0	0	6	-6	-50	14	+2	+16.7	0	-12	-100
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	13.0	13.4	+0.4	+3.1	12.8	-0.2	-1.5	13.1	+0.1	+0.8	13.0	0	0
Fuel Economy													
FTP 1/100 km (mpg)	10.65 (22.09)	10.31 (22.81)	-0.34 (+0.72)	-3.2 (+3.3)	9.96 (23.61)	-0.69 (+1.52)	-6.5 (+6.9)	10.83 (21.71)	+0.18 (-0.38)	+1.7 (-1.7)	10.53 (22.33)	-0.12 (+0.24)	-1.1 (+1.1)
Highway 1/100 km (mpg)	8.52 (27.62)	8.49 (27.72)	-0.03 (+0.1)	-0.4 (+0.4)	8.48 (27.75)	-0.04 (+0.13)	-0.5 (+0.5)	8.95 (26.29)	+0.43 (-1.33)	+5.0 (-4.8)	8.58 (27.41)	+0.06 (-0.21)	+0.7 (-0.8)
Emissions,													
HC, gm/km (gm/mi)	0.45 (0.72)	0.42 (0.67)	-0.03 (-0.05)	-6.9 (-6.9)	0.42 (0.67)	-0.03 (-0.05)	-6.9 (-6.9)	0.46 (0.74)	+0.01 (+0.02)	+2.8 (+2.8)	0.49 (0.79)	+0.04 (+0.07)	+9.7 (+9.7)
CO, gm/km (gm/mi)	6.19 (9.96)	6.04 (9.72)	-0.15 (-0.24)	-2.4 (-2.4)	4.98 (8.02)	-1.21 (-1.94)	-19.5 (-19.5)	8.25 (13.28)	+2.06 (+3.32)	+33.3 (+33.3)	8.12 (13.06)	+1.93 (+3.1)	+31.1 (+31.1)
NOx, gm/km (gm/mi)	1.15 (1.85)	0.99 (1.59)	-0.16 (-0.26)	-14.1 (-14.1)	1.30 (2.10)	+0.15 (+0.25)	+13.5 (+13.5)	1.09 (1.76)	-0.06 (-0.09)	-4.9 (-4.9)	1.00 (1.61)	-0.15 (-0.24)	-13.0 (-13.0)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

TABLE A-23

PERFORMANCE OF 1978 VOLVO 245-DL

2.1 LITER (130 CU. IN.) FUEL INJECTION - CALIFORNIA CALIBRATION

	Base	Disconnect O_2 Sensor Modification 1			Adv. Ignition Timing 5° Modification 2			Idle CO @ 4% Modification 3			Combine 1, 2, 3 Modification 4		
			Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]		Δ[1]	%[2]
CRC Driveability Demerits	17	16	-1	-5.9	23	+6	+35.3	26	+9	+52.9	18	+1	+5.9
Acceleration, sec. 16.1 to 96.6 km/h (10 to 60 mph)	14.0	14.2	+0.2	+1.4	13.8	-0.2	-1.4	14.3	+0.3	+2.1	13.7	-0.3	-2.1
Fuel Economy													
FTP 1/100 km (mpg)	12.58 (18.70)	12.85 (18.31)	+0.27 (-0.39)	+2.1 (-2.1)	12.65 (18.59)	+0.07 (-0.11)	+0.6 (-0.6)	12.85 (18.31)	+0.27 (-0.39)	+2.1 (-2.1)	12.99 (18.10)	+0.41 (-0.6)	+3.3 (-3.2)
Highway 1/100 km (mpg)	9.27 (25.36)	9.75 (24.12)	+0.48 (-1.24)	+5.2 (-4.9)	9.85 (23.89)	+0.58 (-1.47)	+6.3 (-5.8)	9.79 (24.02)	+0.52 (-1.34)	+5.6 (-5.3)	9.89 (23.79)	+0.62 (-1.57)	+6.7 (-6.2)
Emissions,													
HC, gm/km (gm/mi)	0.20 (0.32)	0.32 (0.51)	+0.12 (+0.19)	+59.4 (+59.4)	0.19 (0.30)	-0.01 (-0.02)	-6.3 (-6.3)	0.19 (0.31)	-0.01 (-0.01)	-3.1 (-3.1)	1.06 (1.70)	+0.86 (+1.38)	+431 (+431)
CO, gm/km (gm/mi)	2.04 (3.28)	5.97 (9.60)	+3.93 (+6.32)	+193 (+193)	2.39 (3.84)	+0.35 (+0.56)	+17.1 (+17.1)	2.42 (3.90)	+0.38 (+0.62)	+18.9 (+18.9)	26.70 (42.97)	+24.66 (+39.69)	+1210 (+1210)
NOx, gm/km (gm/mi)	0.42 (0.67)	1.02 (1.64)	+0.6 (+0.97)	+145 (+145)	0.47 (0.76)	+0.05 (+0.09)	+13.4 (+13.4)	0.59 (0.95)	+0.17 (+0.28)	+41.8 (+41.8)	0.43 (0.70)	+0.01 (+0.03)	+4.5 (+4.5)

[1] Difference between value for respective modification and base (- decrease, + increase)

[2] Percent change between respective modification and base (- decrease, + increase)

APPENDIX B-1

Driveability Procedure

The driveability procedure used in this test was developed by CRC in 1968 and updated in 1971, 1973, 1975 and 1977.

The drive-away phase of this procedure involves two different driving modes. The first, is a driving cycle consisting of five maneuvers followed by a 30 second idle period. Each maneuver is performed at 0.1 mile increments. At the termination of each maneuver, the driver's evaluation of the car's performance, categorizing the type of malfunction and its severity, is recorded by the observer. The five maneuvers are performed in the following order:

1. 0-25 mph light throttle acceleration
2. 25 mph cruise
3. 25-35 mph light throttle (detent) acceleration
4. 0-35 wide open throttle acceleration
5. 10-25 light throttle acceleration
6. 30 second engine idle

The attached log sheet shows the details of the procedure. This cycle is repeated two more times.

This is followed by a second mode of three cycles in duration. Each of these cycles consist of four maneuvers each followed by 30 second engine idle period. Three of the maneuvers are performed at 0.1 mile increments, while the fourth is a 0-45 mph crowd acceleration (at constant manifold vacuum) of 0.4 mile duration. The four maneuvers are performed in the order shown below:

1. 0-45 crowd acceleration (constant vacuum)
2. 25-35 light throttle (detent) acceleration
3. 0-35 wide open throttle acceleration
4. 10-25 light throttle acceleration
5. 30 second engine idle

This cycle is then repeated two more times.

The various accelerations described in the above maneuvers are performed at predetermined manifold vacuum conditions, with the aide of a vacuum gauge.

These accelerations are defined below:

Test Run

Operation of a car throughout the prescribed sequence of operating conditions and/or maneuvers for a single test fuel.

CRC driveability data sheet

							Temperatures		Starting Time, sec.				Idle N.	Idle Dr.
Card	Run No.	Car	Fuel	Rater	Date	Time	Soak	Run	Initial	Restart 1	Restart 2	Restart 3	Ruf Stalls	Ruf Stalls
1	2 3 4	5 6 7	8	9	10 11 12	13 14 15 16	17 18	19 20	21 22 23	24 25 26	27 28 29	30 31 32	33 34 35	36 37 38

Card 2 Run No. 1 2 3 4

0.0 0-25 Lt. Th.	0.1 25 Cruise	0.2 25-35 Detent	0.3 0-35 WOT	0.4 10-25 Lt. Th.	0.5 Idle
Hes Stm Srg Bkf Stalls Ac Dc	Hes Stm Srg Bkf Stalls Ac Dc	Hes Stm Srg Bkf Stalls Ac Dc	Hes Stm Srg Bkf Stalls Ac Dc	Hes Stm Srg Bkf Stalls Ac Dc	Ruf Stalls
39 40 41 42 43 44	45 46 47 48 49 50	51 52 53 54 55 56	57 58 59 60 61 62	63 64 65 66 67 68	69 70
0.5	0.6	0.7	0.8	0.9	1.0
5 6 7 8 9 10	11 12 13 14 15 16	17 18 19 20 21 22	23 24 25 26 27 28	29 30 31 32 33 34	35 36
1.0	1.1	1.2	1.3	1.4	1.5
37 38 39 40 41 42	43 44 45 46 47 48	49 50 51 52 53 54	55 56 57 58 59 60	61 62 63 64 65 66	67 68

Card 3 Run No. 1 2 3 4

Card 4 Run No. 1 2 3 4

1.5 0-45 Crowd	1.9 25-35 Detent	2.0 0-35 WOT	2.1 10-25 Lt. Th.	2.2 Idle	
Hes Stm Srg Bkf Stalls Ac Dc	Hes Stm Srg Bkf Stalls Ac Dc	Hes Stm Srg Bkf Stalls Ac Dc	Hes Stm Srg Bkf Stalls Ac Dc	Ruf Stalls	
5 6 7 8 9 10	11 12 13 14 15 16	17 18 19 20 21 22	23 24 25 26 27 28	29 30	
2.2	2.6	2.7	2.8	2.9	
31 32 33 34 35 36	37 38 39 40 41 42	43 44 45 46 47 48	49 50 51 52 53 54	55 56	
2.9	3.3	3.4	3.5	3.6	C for Comment ☐
5 6 7 8 9 10	11 12 13 14 15 16	17 18 19 20 21 22	23 24 25 26 27 28	29 30	31

Comments: ______________________________

____

Maneuver

A specified single vehicle operation or change of operating condition (such as idle, acceleration or cruise) that constitutes one segment of the driveability driving schedule.

Road Load

Operation at a prescribed constant vehicle speed with a fixed throttle position on a level road. Cruise conditions are intended to be road load operation.

Wide Open Throttle (WOT) Acceleration

"Floorboard" acceleration through the gears from prescribed starting speed. Rate at which throttle is depressed is to be as fast as possible without producing tire squeal or appreciable slippage.

Part Throttle (PT) Acceleration

An acceleration made at any defined throttle position, or consistent change in throttle position, less than WOT. Several PT accelerations are used. They are:

Light Throttle (LT th) - All light throttle accelerations are begun by opening the throttle to an initial manifold vacuum and maintaining constant throttle position throughout the remainder of the acceleration. The vacuum selected is that which just precedes carburetor power enrichment as indicated by carburetor flow curves. These vacuum settings will be obtained from the car manufacturers for each test car.

Crowd - An acceleration made at a constant intake manifold vacuum throughout the acceleration. Throttle opening continually increasing with increasing engine speed. Crowd acceleration vacuums to be used in each car are the same as the detent vacuums.

Detent - All detent accelerations are begun by opening the throttle to the downshift position as indicated by transmission shift characteristic curves. Manifold vacuum corresponding to this point at 25 mph is determined for each car prior to the first driveability test. Maintain constant throttle position to 35 mph terminal speed.

At the end of each maneuver, the car's performance is evaluated by the driver using the categories indicated below:

Stall

Any occasion during a test that the engine stops with the ignition on. Two types of stall, indicated by location on the data sheet, are:

Stall; idle - Any stall experienced when the vehicle is not in motion, or when a maneuver is not being attempted.

Driveability Procedure

Stall; driving

Any stall experienced during motion, or coincidental to initiation or elimination of motion of the vehicle.

Idle Roughness

An evaluation of the idle quality or degree of smoothness while the engine is idling.

Backfire

An explosion in the induction or exhaust system.

Hesitation

A temporary lack of initial response to changes of throttle position to increase acceleration rate.

Stumble

A short, sharp reduction in acceleration rate experienced under acceleration or road conditions.

Surge

A continued or transient condition of fluctuations in power, experienced as changes in acceleration rate, which are short or long, cyclic, and occurring at any speed and/or load.

The severity level of the malfunctions shown above are defined below with the obvious exception of stalls.

Trace (T)

A level of malfunction severity that is just discernible to a test driver but not to most laymen. A severity level of one (1) demerit.

Moderate (M)

A level of malfunction severity that is probably noticeable to the average layman. A severity level of two (2) demerits.

Heavy

A level of malfunction severity that is pronounced and obvious to both test driver and layman. A severity level of four (4) demerits.

Driveability Procedure

A T, M, H, is entered in the appropriate block on the data sheet to indicate both the occurrence of the malfunction and its severity. More than one type of malfunction may be recorded for each maneuver. If no malfunction occurs, enter a dash (-) to indicate that the maneuver was performed and the car performance was satisfactory during that maneuver.

A data rating system provides for the vehicle malfunctions and severity level experienced by the driver to be translated into a demerit scale, which allows for a numerical ranking of driveability quality. As shown above, the severity levels have been summarized by applying demerits to the three levels: Trace = 1, Moderate = 2, and Heavy = 4. These demerits are then multiplied by the following weighting factors:

Malfunction	Weighting Factor
Starting time (sec - 2.0)	1
Idle roughness	1
Hesitation	6
Stumble	6
Backfire	6
Surge	4
Stall, idle	8
Stall, driving	32

Demerits on each data sheet are totaled, counting only the maximum weighted demerit on each line (maneuver), to obtain the total weighted demerits (TWD) for each run. Thus, if two malfunctions occurred in one maneuver, such as a heavy hesitation (24 demerits and a trace stumble (6) demerits), only the heavy hesitation would contribute to the TWD for the run.

Cool Down Procedure

The CRC Intermediate Temperature Driveability Procedure has been adapted to the chassis dynamometer using a three-hour forced soak to bring the vehicle temperatures down to the test temperature. For a test temperature of 16°C (60°F) the forced soak procedure consists of opening the hood and allowing temperature controlled room air (16°C) to be circulated at 24 kph over the frontal area of the vehicle. For a lower test temperature, e.g. 4°C, the above procedure plus the use of an auxiliary pump and external radiator placed in the path of the 24 kph room air temperature is required. The pump is connected to the inlet-outlet radiator hoses to the engine block, which allows circulation of engine coolant through the external radiator and the block. At 16°C either of the above procedures are adequate to bring the engine temperature, carburetor air, engine oil, engine coolant and transmission fluid down to the test temperature within a three-hour soak period.

At the 60°F test temperature specified in the contract, the driveability test work conducted in this program was done without an auxiliary pump. The data in Tables B-1 and B-2 compares the cool-down rates with

Cool Down Procedure

and without auxiliary cooling for two test cars, Plymouth Volare 225-F and Ford Granada 302-C, used in this program. Temperatures were measured using thermocouples placed (1) in the air horn for carburetor air, (2) in the oil sump through the drain plug for engine oil, (3) at the coolant temperature sensor for coolant temperature and (4) through the transmission pan for transmission fluid. This data shows the transmission fluid to be the most difficult to cool down. However, transmission fluid temperatures reached test temperatures ± 4°F before the end of the three hour soak period. Also shown on Tables B-1 and B-2 are the driveability test results (single determinations) using the two soak procedures. Within the test accuracy there is no difference in driveability demerits between the two methods.

TABLE B-1

FORD GRANADA 302-C FORCED COOL DOWN DATA

TEMPERATURE, °F WITH NO AUXILIARY COOLING

Soak-time Hrs.	Carburetor Air	Engine Oil	Coolant	Trans.	Room Air	Driveability Demerits
0.0	100	134	196	180	69	
0.5	66	74	176	111		
1.0	61	61	130	88	57	
1.5	62	62	100	78		
2.0	62	62	83	73	60	
2.5	64	64	73	70		
3.0	64	64	64	64	61	16

TEMPERATURE, °F WITH AUXILIARY COOLING

0.0	126	155	190	188	61	
0.5	62	63	63	106		
1.0	61	61	61	78	59	
1.5	63	63	63	68		
2.0	63	63	63	63	61	
2.5	65	65	65	65		
3.0	61	61	61	61	59	30

TABLE B-2

PLYMOUTH VOLARE 225-F FORCED COOL DOWN DATA

TEMPERATURE, °F WITH NO AUXILIARY COOLING

Soak-time Hrs.	Carburetor Air	Engine Oil	Coolant	Trans.	Room Air	Driveability Demerits
0.0	72	170	189	163	64	
0.5	67	92	141	109		
1.0	64	69	100	90	61	
1.5	64	64	81	79		
2.0	64	64	69	69	61	
2.5	63	61	63	63		
3.0	62	62	62	62	60	435

TEMPERATURE, °F WITH AUXILIARY COOLING

Soak-time Hrs.	Carburetor Air	Engine Oil	Coolant	Trans.	Room Air	Driveability Demerits
0.0	73	167	190	153	67	
0.5	65	97	65	98		
1.0	62	73	62	79	61	
1.5	64	64	64	69		
2.0	64	64	64	64	62	
2.5	63	63	63	63		
3.0	62	62	62	62	61	416

APPENDIX B-2

EMISSION LAB INSTRUMENTATION

Measurement	Analyzer
Carbon Monoxide (CO)	Mine Safety Appliances Co. Model 200 FR Lira & Model 202 Lira Infrared Analyzer (NDIR) Maximum sensitivity = 0 to 50 ppm range
Carbon Dioxide (CO_2)	Mine Safety Appliances Co. Model 303 Lira Infrared Analyzer Calibrated for Maximum sensitivity = 0 to 1% scale
Unburned Hydrocarbons (UNHC)	Mine Safety Appliances Co. Flame Ionization Detector Model 800
Nitrogen Oxides (NOx)	Thermo Electron Corp. Model 10A Self Contained Chemiluminescent NO - NOx Gas Analyzer

Sampler

Constant Volume Sampler (CVS) - Scott Research Laboratories Inc.
Model 301 Mass Sampling System with Water heater-cooler control unit.

TABLE C-1

REPEATABILITY OF EMISSION AND FUEL ECONOMY DATA

CAR	K	J	N	P	B	E	F	H	S	O	M	Q	U
FTP Fuel Economy													
S^2	.02	.04	.03	.05	.04	.11	.08	.08	.01	.02	.004	.13	.27
S	.16	.20	.17	.22	.19	.33	.29	.29	.10	.14	.06	.36	.52
$\bar{X}$	17.18	19.33	12.34	17.03	14.55	16.18	14.41	14.24	10.95	13.54	13.83	12.31	22.46
%CV	.91	1.02	1.42	1.29	1.34	2.05	2.01	2.04	0.94	1.00	.45	2.89	2.31
HFE Fuel Economy													
S^2	.07	.14	.16	.25	.28	.32	.16	.66	.10	.09	.15	.54	.57
S	.26	.37	.40	.50	.53	.57	.39	.82	.31	.30	.38	.74	.75
$\bar{X}$	22.34	25.70	17.48	22.28	19.10	23.24	20.18	19.86	17.23	18.35	18.49	17.85	27.31
%CV	1.18	1.44	2.29	2.22	2.76	2.44	1.95	4.11	1.81	1.64	2.08	4.12	2.75
HC Emissions													
S^2	.02	.004	.01	.07	.01	.01	.04	.001	.003	.004	.005	.02	.002
S	.14	.07	.12	.26	.11	.10	.19	.03	.05	.07	.07	.15	.05
$\bar{X}$	2.03	1.10	0.76	1.62	1.57	.96	1.74	.74	1.05	1.31	1.57	1.13	.72
%CV	6.83	6.13	15.23	15.85	7.05	10.34	10.93	3.98	4.78	5.08	4.40	12.93	6.40
CO Emissions													
S^2	.96	.23	.49	7.46	1.40	6.10	4.54	1.43	1.60	1.30	1.01	13.30	1.58
S	.98	.48	.70	2.73	1.18	2.47	2.13	1.19	1.27	1.14	1.01	3.65	1.26
$\bar{X}$	16.36	20.10	4.38	15.37	23.77	20.49	25.62	7.85	16.75	11.82	8.37	16.79	10.71
%CV	5.99	2.40	15.98	17.76	4.98	12.06	8.32	15.21	7.55	9.63	12.02	21.73	11.74
NOx Emissions													
S^2	.01	.01	.01	.02	.01	.02	.04	.10	.01	.04	.02	.03	.04
S	.10	.10	.08	.14	.09	.13	.21	.31	.10	.21	.15	.17	.20
$\bar{X}$	2.85	2.04	1.54	2.66	2.74	2.95	2.71	3.13	1.85	3.70	2.89	1.76	1.77
%CV	3.66	4.79	4.95	5.40	3.43	4.36	7.80	9.96	5.60	5.64	5.17	9.34	11.15

TABLE C-1

REPEATABILITY OF EMISSION AND FUEL ECONOMY DATA

CAR	A	R	L	G	D	I	T	C	V	AVG.	RANGE LOW	RANGE HIGH
FTP Fuel Economy												
S^2	.70	.06	.02	.03	.30	.09	.51	.13	.07			
S	.84	.25	.13	.17	.54	.29	.72	.35	.27			
$\bar{X}$	22.84	10.79	14.97	15.34	16.37	14.43	13.49	19.73	18.40			
%CV	3.67	2.29	.90	1.13	3.33	2.04	5.31	1.79	1.46	1.89	0.45	5.31
HFE Fuel Economy												
S^2	.69	.27	.05	.28	.37	.21	.48	.16	.17			
S	.83	.52	.23	.53	.61	.46	.70	.41	.41			
$\bar{X}$	31.06	15.87	18.79	20.34	23.36	20.18	16.65	25.67	24.23			
%CV	2.68	3.26	1.22	2.60	2.61	2.26	4.18	1.58	1.70	2.40	1.18	4.18
HC Emissions												
S^2	.01	.002	.01	.02	.10	.001	.004	.01	.001			
S	.09	.04	.11	.15	.32	.03	.07	.08	.04			
$\bar{X}$	.76	.46	.89	1.14	1.68	.79	.32	1.83	.63			
%CV	11.21	9.09	12.28	12.92	18.95	4.09	20.63	4.31	5.97	9.52	3.98	20.63
CO Emissions												
S^2	6.69	.16	7.51	5.13	1.00	.69	2.84	8.16	.52			
S	2.59	.40	2.74	2.27	1.00	.83	1.68	2.86	.72			
$\bar{X}$	13.32	4.07	12.84	25.95	15.47	7.49	6.65	61.01	12.72			
%CV	19.42	9.81	21.35	8.73	6.47	11.10	25.34	4.68	5.68	12.71	2.40	25.34
NOx Emissions												
S^2	.02	.01	.02	.002	.12	.02	.03	.02	.004			
S	.13	.12	.14	.04	.35	.13	.17	.12	.07			
$\bar{X}$	2.56	1.96	3.28	1.62	3.04	3.41	1.63	1.17	.94			
%CV	4.99	6.13	4.40	2.46	11.41	3.90	10.27	10.54	6.95	6.45	2.46	11.41

TABLE C-2

PERFORMANCE OF 1977 CHEVROLET CHEVETTE - CAR NO. W-53
98F CID - 1 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	23.46 24.12 *(22.35 21.87)	24.06 23.76	*(22.32 23.83)	21.74 23.06	21.72 22.04
Highway Fuel Economy (Mi./Gal.)	32.00 32.77 *(30.05 31.16)	31.73 31.37	*(31.51 31.92)	30.51 32.32	28.88 29.33
Emissions					
HC, (Gms./Mi.)	1.07 0.96 *(0.70 0.87)	0.82 0.80	*(0.79 0.73)	0.69 0.60	0.75 0.66
CO, (Gms./Mi.)	16.67 14.77 *(12.26 17.13)	12.94 11.86	*(14.20 11.51)	17.07 9.59	13.43 12.21
NOx, (Gms./Mi.)	1.78 1.82 *(1.92 2.02)	4.76 5.08	*(1.97 1.87)	1.97 2.10	2.00 2.07
Driveability Demerits	118 101	78 100	62 62	75 118	65 76

*( ) Data with Rebuilt Transmission, Retaining Original Governor.

TABLE C-3

PERFORMANCE OF 1977 CHEVROLET CHEVELLE - CAR NO. W-41
305F CID - 2 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	14.63 14.64	14.88 15.08	14.84 14.52	14.20 13.81	14.61 14.32
Highway Fuel Economy (Mi./Gal.)	18.48 18.88	19.96 19.74	19.96 19.24	17.18 18.39	19.18 19.95
Emissions					
HC, (Gms./Mi.)	0.99 1.02	1.16 1.14	2.37 2.18	1.12 1.14	2.12 2.41
CO, (Gms./Mi.)	12.78 13.49	15.43 13.95	34.26 32.79	18.98 18.88	37.04 40.06
NOx, (Gms./Mi.)	2.69 2.74	3.76 3.65	2.70 2.86	1.92 2.08	2.43 2.58
Driveability Demerits	105 129	124 112	136 105	105 114	124 156 128

TABLE C-4

PERFORMANCE OF 1978 PONTIAC SUNBIRD - CAR NO. X-02
151C CID - 2 BBL CARB. (CALIF.)

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	21.47 21.74	18.15 18.87	18.54 18.80	21.88 21.19	18.49 18.15
Highway Fuel Economy (Mi./Gal.)	28.08 28.47	24.64 24.39	24.56 24.13	27.34 26.36	24.63 24.10
Emissions					
HC, (Gms./Mi.)	0.76 0.86	2.67 2.54	2.52 2.70	0.56 0.53	2.58 2.54
CO, (Gms./Mi.)	9.25 8.25	97.81 96.49	95.25 90.88	7.80 7.78	94.44 102.17
NOx, (Gms./Mi.)	1.95 1.95	0.60 0.72	0.76 0.49	1.82 1.96	0.60 0.81
Driveability Demerits	130 119 136 84	86 111	77 116 85 78	112 97	94 111

TABLE C-5

PERFORMANCE OF 1977 PONTIAC GRAND PRIX - CAR NO. W-56
301F CID - 2 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	16.44 16.47	16.07 15.79	16.36 16.74	17.05 16.27	15.51 16.97
Highway Fuel Economy (Mi./Gal.)	21.93 23.13 24.58 22.84	22.45 21.43	23.86 24.00	24.23 24.20	23.24 23.94
Emissions					
HC, (Gms./Mi.)	1.11 1.21	1.41 1.17	2.50 2.42	1.58 2.55	1.45 1.42
CO, (Gms./Mi.)	8.85 9.57	9.70 8.59	24.48 21.76	26.49 26.09	9.16 10.00
NOx, (Gms./Mi.)	1.88 1.45	4.88 5.54	1.74 1.74	4.22 4.82	2.29 1.82
Driveability Demerits	51 56	65 88	67 67	56 64	52 66

TABLE C-6

PERFORMANCE OF 1977 BUICK SKYLARK - CAR NO. W-42
231F CID - 2 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	15.73 15.29	16.98 17.11	16.12 16.21	16.87 17.43	15.89 15.64
Highway Fuel Economy (Mi./Gal.)	22.08 23.04	23.49 24.27	23.09 22.48	23.66 24.06	23.21 22.63
Emissions					
HC, (Gms./Mi.)	0.66 0.82	0.97 1.09	1.12 0.89	1.34 1.33	0.67 0.75
CO, (Gms./Mi.)	20.38 16.16	19.87 20.34	24.34 20.18	25.24 22.55	13.09 15.71
NOx, (Gms./Mi.)	1.60 1.71	5.09 4.78	1.48 1.57	4.87 4.65	1.84 1.86
Driveability Demerits	115 95	97 60	45 22	52 73	127 150

TABLE C-7

PERFORMANCE OF 1978 BUICK REGAL - CAR NO. A-245
231F CID - 4 BBL. CARB. - (TURBOCHARGE)

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	16.13 16.30	15.02 15.22	14.78 15.19	14.18 13.93	16.30 16.34
Highway Fuel Economy (Mi./Gal.)	20.48 21.49	19.39 18.53	21.38 22.24	18.25 17.73	21.89 22.02
Emissions					
HC, (Gms./Mi.)	0.82 0.80	0.88 0.83	0.91 0.56	2.33 2.25	1.14 0.85
CO, (Gms./Mi.)	10.19 9.61	10.90 10.08	17.16 17.63	80.25 87.11	9.17 7.43
NOx, (Gms./Mi.)	1.28 1.24	4.07 4.16	0.98 0.95	0.38 0.31	1.40 1.42
Driveability Demerits	92 90	78 86	76 73	36 56	106 100

TABLE C-8

PERFORMANCE OF 1977 BUICK CENTURY - CAR NO. W-43
350F CID - 2 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	14.41	14.53	13.21	14.27	14.95
	14.41	15.35	13.54	14.50	14.98
					14.92
Highway Fuel Economy (Mi./Gal.)	19.49	20.25	19.28	20.07	20.73
	20.14	21.08	19.34	20.73	20.71
					20.71
Emissions					
HC, (Gms./Mi.)	0.95	0.84	2.81	2.14	1.64
	0.67	0.75	2.83	1.68	2.23
					2.48
CO, (Gms./Mi.)	11.15	10.86	51.23	30.72	19.05
	9.91	8.02	49.68	24.94	29.85
					29.86
NOx, (Gms./Mi.)	1.76	5.41	1.34	1.26	4.71
	1.57	4.81	1.17	1.23	4.18
					4.32
Driveability Demerits	105	42	87	79	99
	104	69	87	100	83

TABLE C-9

PERFORMANCE OF 1977 OLDSMOBILE CUTLASS - CAR NO. W-44
350F CID - 4 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	14.67 14.53	14.17 15.43 14.57	14.27 14.46	13.81 13.61	13.76 13.57
Highway Fuel Economy (Mi./Gal.)	19.94 19.72	18.94 22.33 19.80	19.74 20.09	19.11 19.54 19.17	19.47 19.20
Emissions					
HC, (Gms./Mi.)	0.77 0.73	0.73 0.72 0.78	0.74 0.71	0.78 0.83	0.67 0.68
CO, (Gms./Mi.)	7.36 7.83	6.33 6.03 7.56	9.83 9.21	14.08 9.45	7.09 7.96
NOx, (Gms./Mi.)	1.87 2.13	8.60 6.65 7.57	1.90 1.92	2.33 3.01	2.44 2.21
Driveability Demerits	180 > 123* 67	108 146 > 90* 18	76 78	104 66	79 62
*Average for an individual rater	131	78			

TABLE C-10

PERFORMANCE OF 1977 OLDSMOBILE "98" - CAR NO. W-57
403F CID - 4 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	14.23 14.30	14.30 14.11	14.34 14.54	14.70 14.61	14.07 15.00 14.17
Highway Fuel Economy (Mi./Gal.)	19.30 19.71	19.65 19.51	20.31 20.28	21.69 20.56	20.15 20.87 20.04
Emissions					
HC, (Gms./Mi.)	0.80 0.84	0.88 0.79	0.85 0.85	0.74 0.76	0.71 0.72 0.70
CO, (Gms./Mi.)	7.03 7.92	7.09 7.43	8.68 8.39	5.28 6.95	7.59 8.97 6.81
NOx, (Gms./Mi.)	2.67 2.44	8.23 8.38	2.21 2.28	2.06 2.07	2.02 1.73 2.06
Driveability Demerits	84 84	84 102	66 56	90 86	30 48

TABLE C-11

PERFORMANCE OF 1977 FORD PINTO - CAR NO. W-38
140F CID - 2 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	18.67 18.41	19.48 19.86	20.09 20.2	18.86 19.66	18.94 18.66
Highway Fuel Economy (Mi./Gal.)	24.53 24.39	26.22 26.97	25.81 26.73	25.58 26.86	24.65 25.47
Emissions					
HC, (Gms./Mi.)	0.85 0.89	0.90 0.88	0.80 0.91	1.29 1.67	1.36 1.24
CO, (Gms./Mi.)	15.35 15.17	16.52 15.78	11.91 12.86	28.03 30.16	27.62 26.35
NOx, (Gms./Mi.)	1.33 1.57	4.06 4.21	1.84 1.98	1.52 1.33	1.37 1.41
Driveability Demerits	155 152	138 168	122 107	77 108	143 132

TABLE C-12

PERFORMANCE OF 1977 FORD MAVERICK - CAR NO. W-37
250F CID - 1 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	16.84 16.98	17.22 17.02	17.76 17.64	17.10 17.48	16.80 16.96
Highway Fuel Economy (Mi./Gal.)	22.04 22.36	21.51 21.92	22.53 22.98	22.67 23.12	22.01 22.19
Emissions					
HC, (Gms./Mi.)	1.57 1.93	1.27 1.36	1.81 1.68	2.41 2.55	2.79 2.92
CO, (Gms./Mi.)	11.56 14.26	13.63 12.59	12.95 11.85	21.61 21.53	21.74 21.84
NOx, (Gms./Mi.)	1.48 1.42	7.81 7.55	1.85 1.97	1.48 1.51	1.80 1.65
Driveability Demerits	147 173	118 138	108 86	126 164	140 164

TABLE C-13

PERFORMANCE OF 1977 FORD MAVERICK - CAR NO. W-55
250C CID - 1 BBL. CARB. (CALIF.)

	Base		Modification 1	Modification 2	Modification 3
FTP Fuel Economy (Mi./Gal.)	14.54	*14.63	15.64	14.47	15.63
	14.54	**14.59	15.65	14.71	15.28
Highway Fuel Economy (Mi./Gal.)	18.19	*18.43	19.61	18.29	19.91
	18.15	**18.02	19.68	18.31	19.32
Emissions					
HC, (Gms./Mi.)	1.00	*0.96	0.78	0.79	1.25
	0.77	**0.88	0.69	0.79	1.02
CO, (Gms./Mi.)	12.75	*11.87	10.03	9.19	21.84
	10.96	**18.40	7.01	8.95	17.36
NOx, (Gms./Mi.)	1.36	*1.27	6.56	1.21	6.00
	1.20	**1.00	6.59	1.29	6.32
Driveability Demerits		104	44	43	54
		126	56	62	40

* Idle CO @ 0.3%
** Rebuild Carb. Idle CO @ 0.3%

TABLE C-14

PERFORMANCE OF 1977 FORD GRANADA - CAR NO. W-50
302F CID - 2 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	14.24 14.32 14.11	14.05 14.09	13.93 13.99	13.81 13.86	13.10 13.05
Highway Fuel Economy (Mi./Gal.)	19.58 18.51 19.49	18.31 18.32	19.04 18.79	18.83 18.38	17.39 17.78
Emissions					
HC, (Gms./Mi.)	1.75 1.91 1.85	1.63 1.64	1.96 1.80	1.26 1.26	1.27 1.20
CO, (Gms./Mi.)	7.90 6.39 8.01	7.37 7.93	7.45 8.29	8.53 8.41	11.99 9.41
NOx, (Gms./Mi.)	2.05 2.06 1.99	7.37 6.93	2.26 2.19	1.65 1.51	1.45 1.49
Driveability Demerits	79 86	53 43	48 49	116 130	90 82

TABLE C-15

PERFORMANCE OF 1977 FORD GRANADA - CAR NO. A-243
302C CID - 2 BBL. V.V. CARB. (CALIF.)

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	12.27	13.24	11.39	12.56	12.52
	12.08	12.86	11.53	12.29	12.70
Highway Fuel Economy (Mi./Gal.)	17.33	17.98	16.55	18.52	17.17
	17.58	18.57	16.47	17.43	17.21
Emissions					
HC, (Gms./Mi.)	0.78	1.04	0.70	0.85	0.78
	0.69	0.81	0.69	0.61	0.66
CO, (Gms./Mi.)	4.92	3.60	4.47	5.46	4.22
	4.88	3.97	4.68	3.29	4.29
NOx, (Gms./Mi.)	1.13	3.33	1.11	1.00	0.97
	1.11	3.53	1.09	1.08	1.07
Driveability Demerits	129 154	4	41 26	72	39
	156 162	3	68 45	54	30

TABLE C-16

PERFORMANCE OF 1977 FORD LTDII - CAR NO. W-49
351F CID - 2 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	13.92 13.65	13.44 13.70	13.46 13.51	13.41 13.43	13.54 13.34
Highway Fuel Economy (Mi./Gal.)	19.23 19.19	18.27 19.09	18.49 18.22	17.62 17.73	18.04 17.66
Emissions					
HC, (Gms./Mi.)	1.21 1.33	1.18 1.22	1.13 1.29	1.37 1.42	1.46 1.46
CO, (Gms./Mi.)	9.17 11.47	10.05 11.29	11.48 9.06	14.44 14.10	13.36 13.76
NOx, (Gms./Mi.)	2.52 2.30	8.68 8.16	2.65 2.96	1.98 1.97	2.80 2.94
Driveability Demerits	222 199	129 123	234 240	250 236	216 231

TABLE C-17

PERFORMANCE OF 1977 PLYMOUTH VOLARE - CAR NO. A-241
225F CID - 1 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	16.27 16.37	18.10 18.04	17.40 17.49	16.99 17.09	16.61 15.94
Highway Fuel Economy (Mi./Gal.)	21.12 21.29	23.13 24.43	22.67 21.98 22.76	22.09 22.49	21.63 21.94
Emissions					
HC, (Gms./Mi.)	1.31 1.37	1.28 1.62	1.33 1.08	2.10 1.94	2.40 1.73
CO, (Gms./Mi.)	10.29 11.47	11.55 11.56	10.70 7.84	23.75 16.59	26.83 23.12
NOx, (Gms./Mi.)	1.93 1.66	6.39 6.28	1.84 2.05	1.75 1.56	1.47 1.67
Driveability Demerits	268 > 269* 269 207	116 196	224 198	379 > 366* 352 360	328 377 329 372

*Average for an individual rater

TABLE C-18

PERFORMANCE OF 1977 PLYMOUTH VOLARE - CAR NO. W-51
318F CID - 2 BBL. CARB.

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	13.12 12.64 11.96	13.66 13.32	11.96 11.90	12.31 11.84 12.21	11.73 11.52
Highway Fuel Economy (Mi./Gal.)	18.71 17.27 17.46	18.83 18.62	17.57 17.23	18.69 16.46 17.25	17.39 17.21
Emissions					
HC, (Gms./Mi.)	1.01 1.00 1.06	0.87 0.91	1.00 0.83	1.65 1.22 1.60	1.33 1.47
CO, (Gms./Mi.)	9.35 13.64 11.95	11.61 13.25	16.96 12.09	25.27 16.66 26.87	23.29 25.79
NOx, (Gms./Mi.)	1.34 1.37 1.58	2.65 2.64	1.34 1.64	1.37 1.76 1.51	1.53 1.69
Driveability Demerits	242 246	197 192 183 206	220 231	257 244	226 241

TABLE C-19

PERFORMANCE OF 1977 PLYMOUTH VOLARE - CAR NO. W-54
318C CID - 2 BBL. CARB. - (CALIF.)

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	10.53 10.61	11.53 11.78	10.75 11.13	11.25 10.63	9.78 9.89
Highway Fuel Economy (Mi./Gal.)	16.22 15.34 14.87	17.75 18.22	15.98 15.18	15.87 15.31	14.26 14.76
Emissions					
HC, (Gms./Mi.)	0.50 0.43	0.41 0.31	0.37 0.37	0.52 0.57	0.59 0.57
CO, (Gms./Mi.)	3.57 3.08	2.99 2.26	3.31 2.91	3.91 3.18	7.57 7.93
NOx, (Gms./Mi.)	1.79 1.97	3.06 2.93	1.72 1.53	1.57 1.76	1.55 1.70
Driveability Demerits	274 263	126 145	240 278	197 224	305 310

TABLE C-20

PERFORMANCE OF 1977 CHRYSLER CORDOBA - CAR NO. W-48
400F CID - 4 BBL. CARB. (LEAN BURN)

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	11.34 11.38	10.70 10.84	11.19 10.99	11.03 10.82	10.59 10.59
Highway Fuel Economy (Mi./Gal.)	17.23 17.29	16.51 17.39	17.61 17.75	17.54 17.86	16.46 16.41 16.70
Emissions					
HC, (Gms./Mi.)	0.68 0.69	0.63 0.67	0.64 0.79	1.58 1.55	1.63 1.64
CO, (Gms./Mi.)	6.11 5.55	9.03 7.80	5.13 7.35	30.42 27.52	33.84 34.76
NOx, (Gms./Mi.)	1.84 1.59	1.90 1.88	1.96 2.10	1.74 1.65	1.86 1.99
Driveability Demerits	183 187	156 170	187 167	207 218	198 187

TABLE C-21

PERFORMANCE OF 1978 AMC CONCORD - CAR NO. W-59
258C CID - 1 BBL CARB. (CALIF.)

	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	13.45	14.37	11.82	13.13	13.20
	12.93	16.15	12.11	13.30	14.46
Highway Fuel Economy (Mi./Gal.)	15.88	19.08	14.80	16.12	16.22
	15.48	21.19	14.73	16.34	16.64
Emissions					
HC, (Gms./Mi.)	0.34	0.22	0.35	0.24	0.51
	0.28	0.24	0.31	0.35	0.35
CO, (Gms./Mi.)	6.27	4.81	10.26	4.26	9.47
	4.86	1.36	7.74	6.91	10.52
NOx, (Gms./Mi.)	1.16	4.48	0.96	1.01	0.86
	1.05	3.97	0.96	0.93	0.88
Driveability Demerits	121	33	150	120	94
	121	35	179	134	118

TABLE C-22

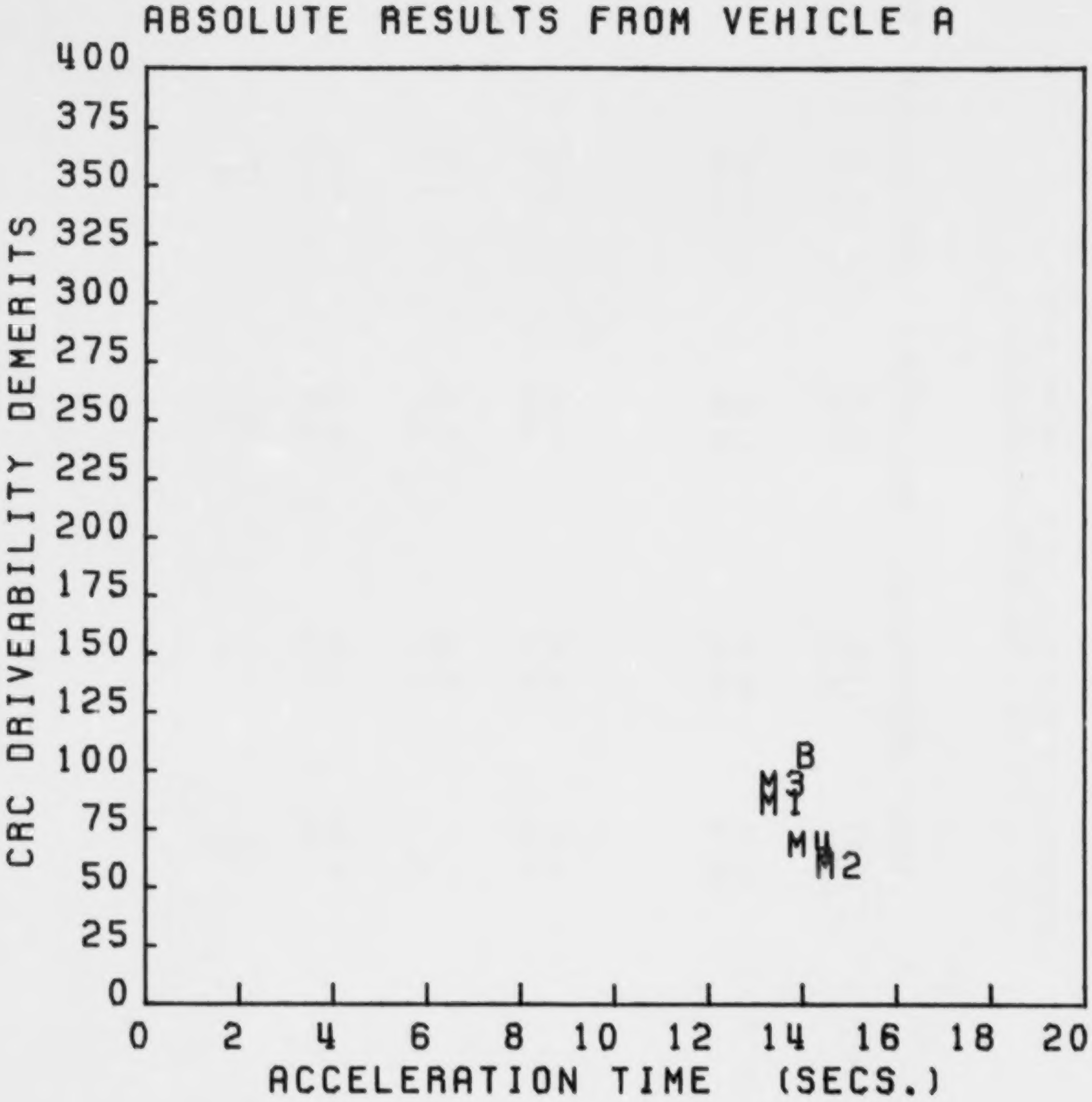
PERFORMANCE OF 1977 TOYOTA COROLLA - CAR NO. W-52
97F CID - 2 BBL. CARB.

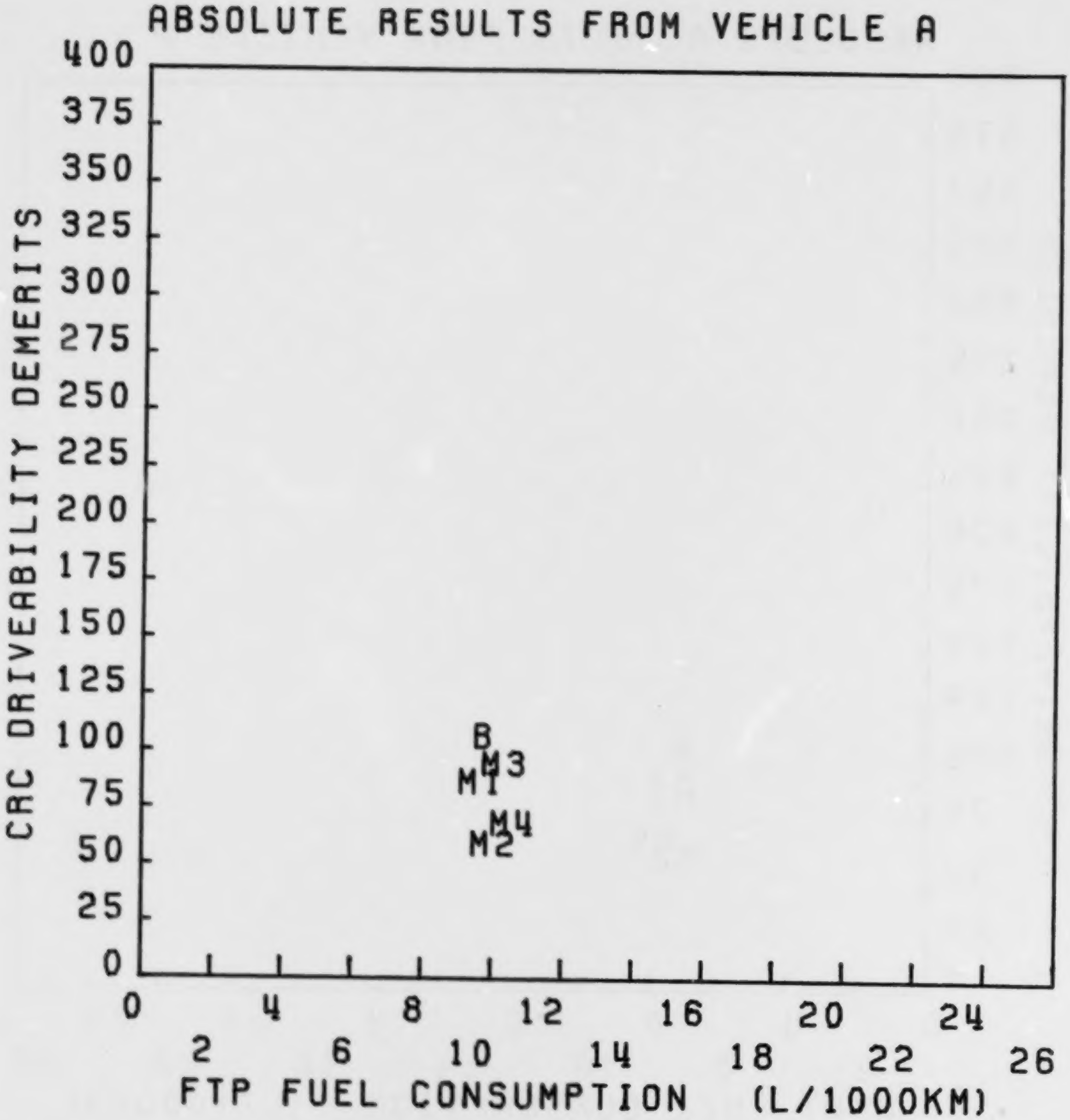
	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	22.07 22.10	22.62 22.99	23.94 23.27	20.83 22.48 21.82	22.02 22.63
Highway Fuel Economy (Mi./Gal.)	26.94 28.29	27.86 27.57	28.36 27.13	25.36 26.99 26.53	27.15 27.67
Emissions					
HC, (Gms./Mi.)	0.73 0.71	0.66 0.68	0.69 0.64	0.82 0.67 0.73	0.82 0.76
CO, (Gms./Mi.)	9.84 10.07	10.19 9.25	8.28 7.76	14.54 11.34 13.96	14.27 11.84
NOx, (Gms./Mi.)	1.90 1.80	1.52 1.66	1.98 2.22	1.91 1.96 1.42	1.51 1.71
Driveability Demerits	12 12	12 12	6 6	18 9	0 0

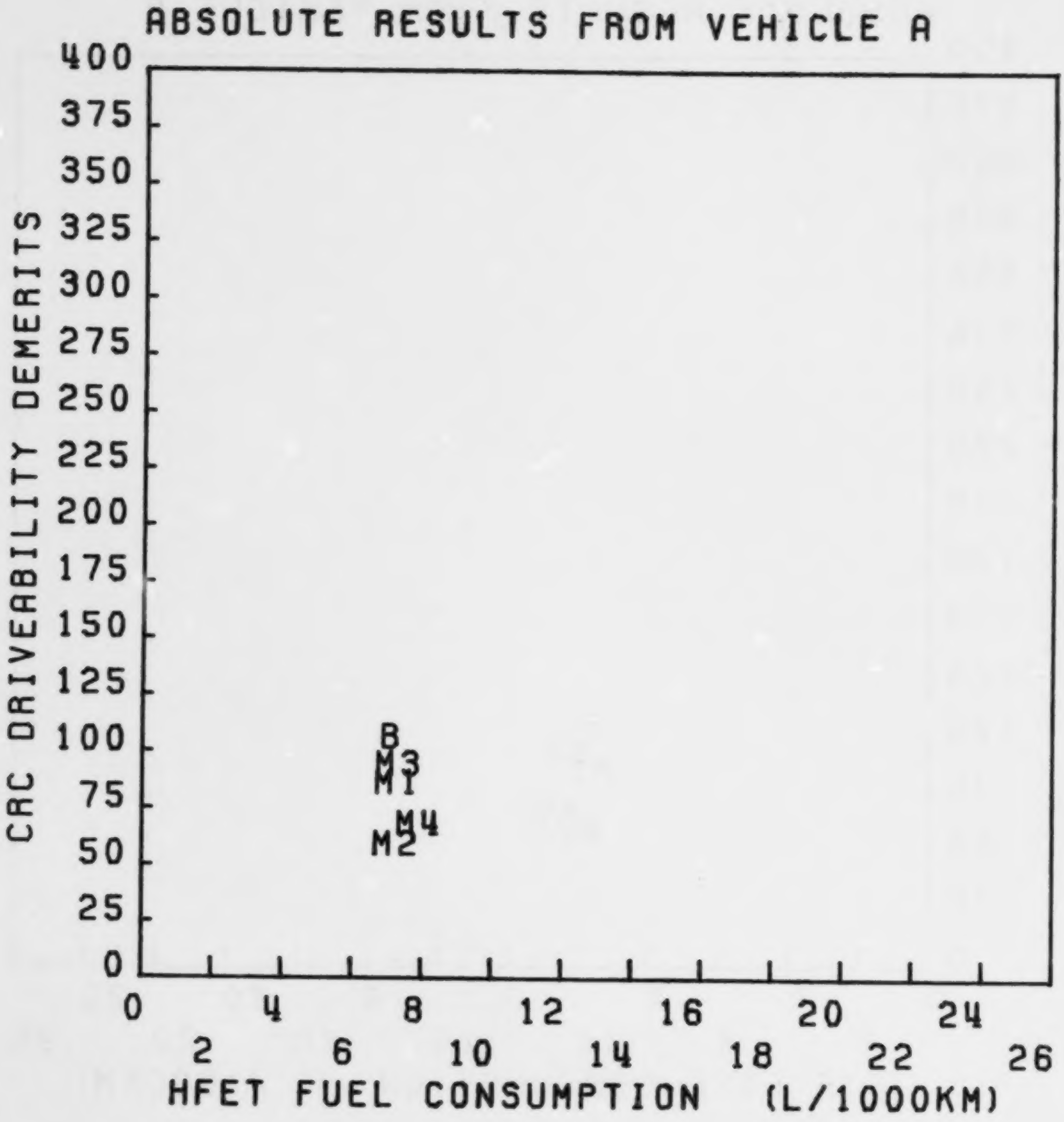
TABLE C-23

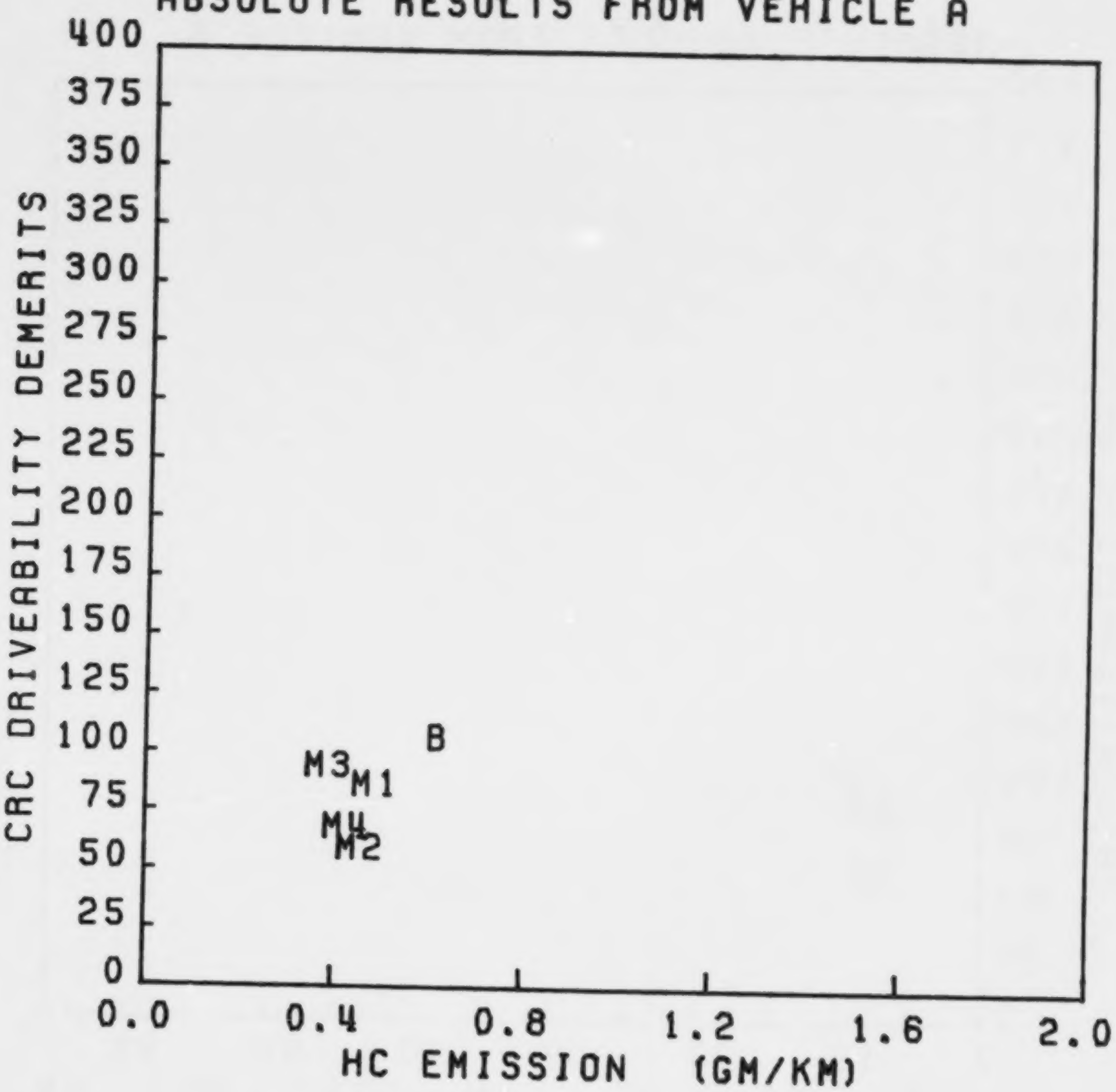
PERFORMANCE OF 1978 VOLVO 245 DL - CAR NO. X-03
130C CID - FUEL INJECTION (CALIF.)

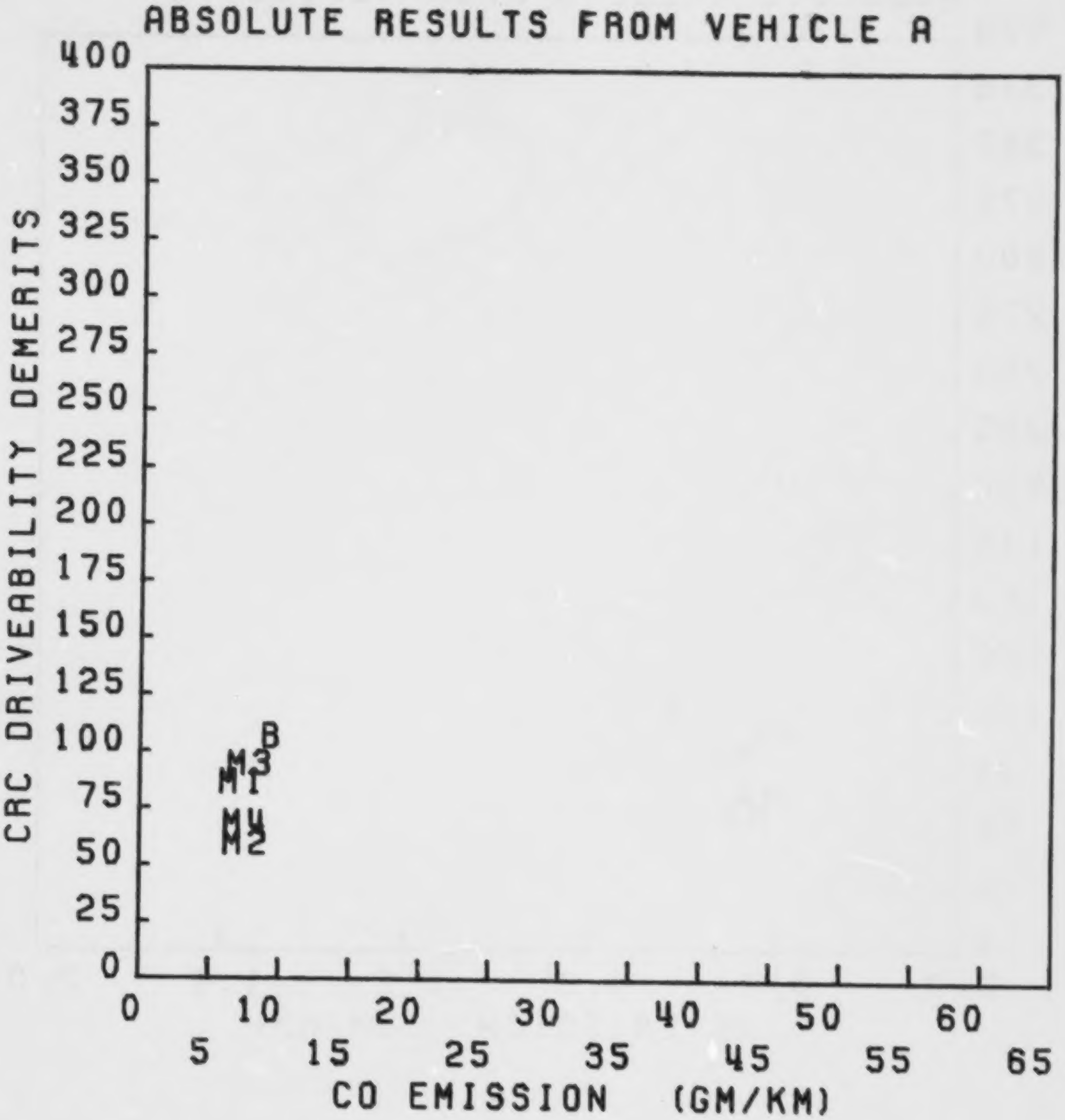
	Base	Modification 1	Modification 2	Modification 3	Modification 4
FTP Fuel Economy (Mi./Gal.)	18.63 18.76	18.44 18.17	18.28 18.89	18.55 18.06	18.16 18.03
Highway Fuel Economy (Mi./Gal.)	25.94 24.78	24.35 23.89	23.92 23.86	24.03 24.00	23.97 23.60
Emissions					
HC, (Gms./Mi.)	0.31 0.32	0.48 0.53	0.31 0.28	0.32 0.30	1.65 1.75
CO, (Gms./Mi.)	3.25 3.31	8.83 10.37	4.31 3.36	3.99 3.80	43.66 42.28
NOx, (Gms./Mi.)	0.70 0.64	1.73 1.56	0.73 0.78	0.93 0.97	0.66 0.74
Driveability Demerits	14 19	13 19	23 23	29 23	15 21

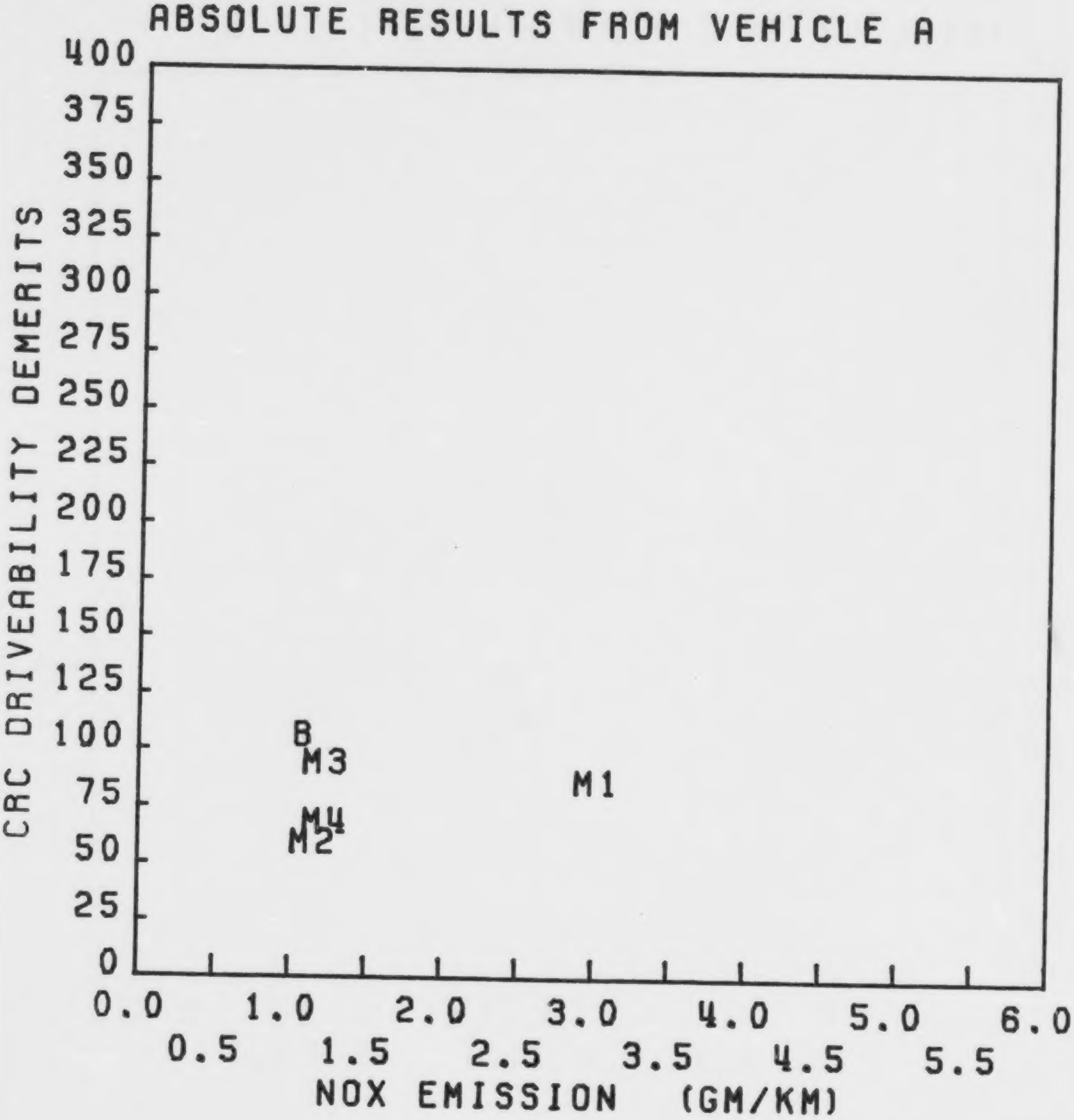

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)
B
M3
M1
M4
M2


ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)
B
M3
M1
M4
M2

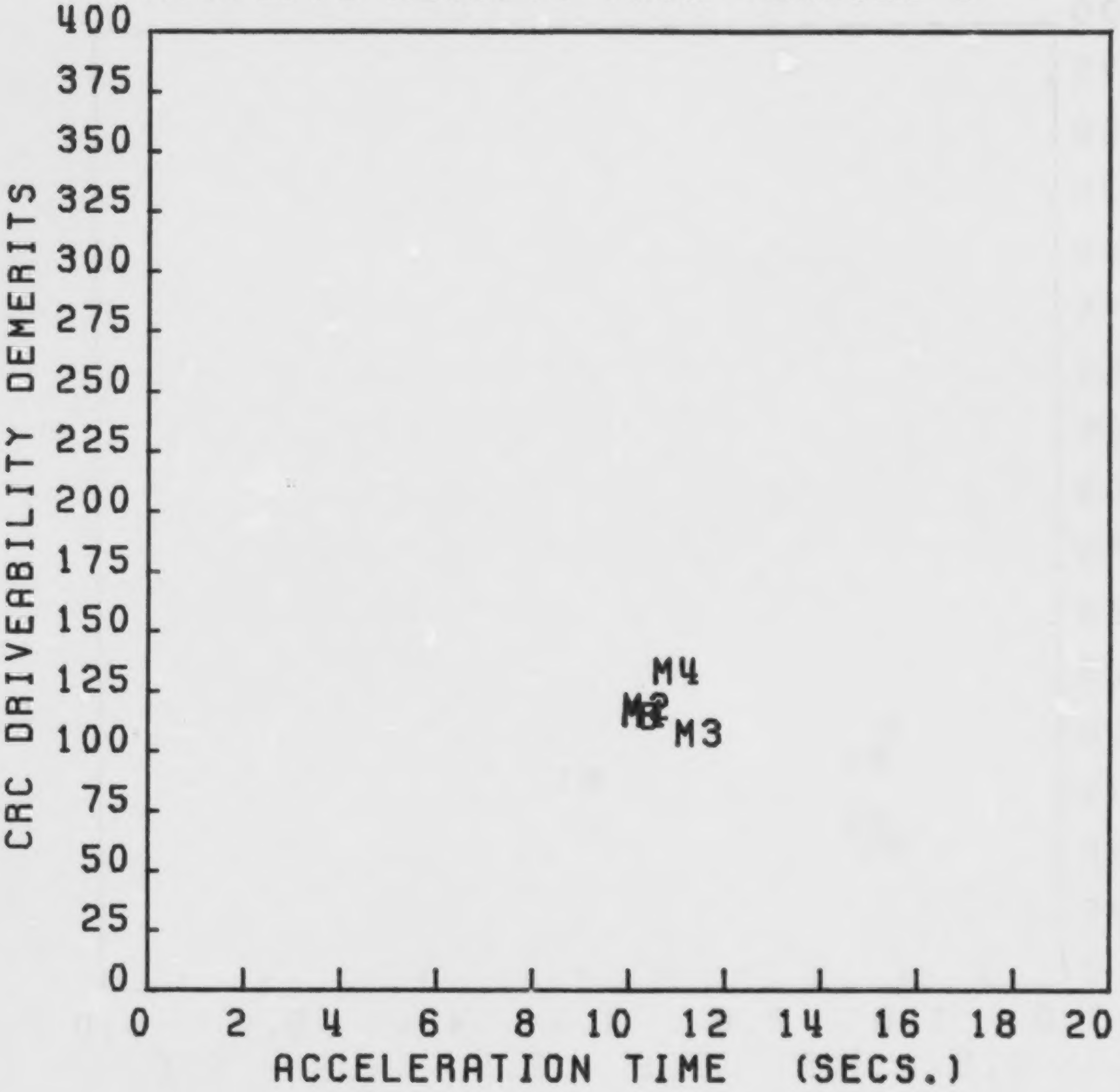

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M1
M4
M2
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

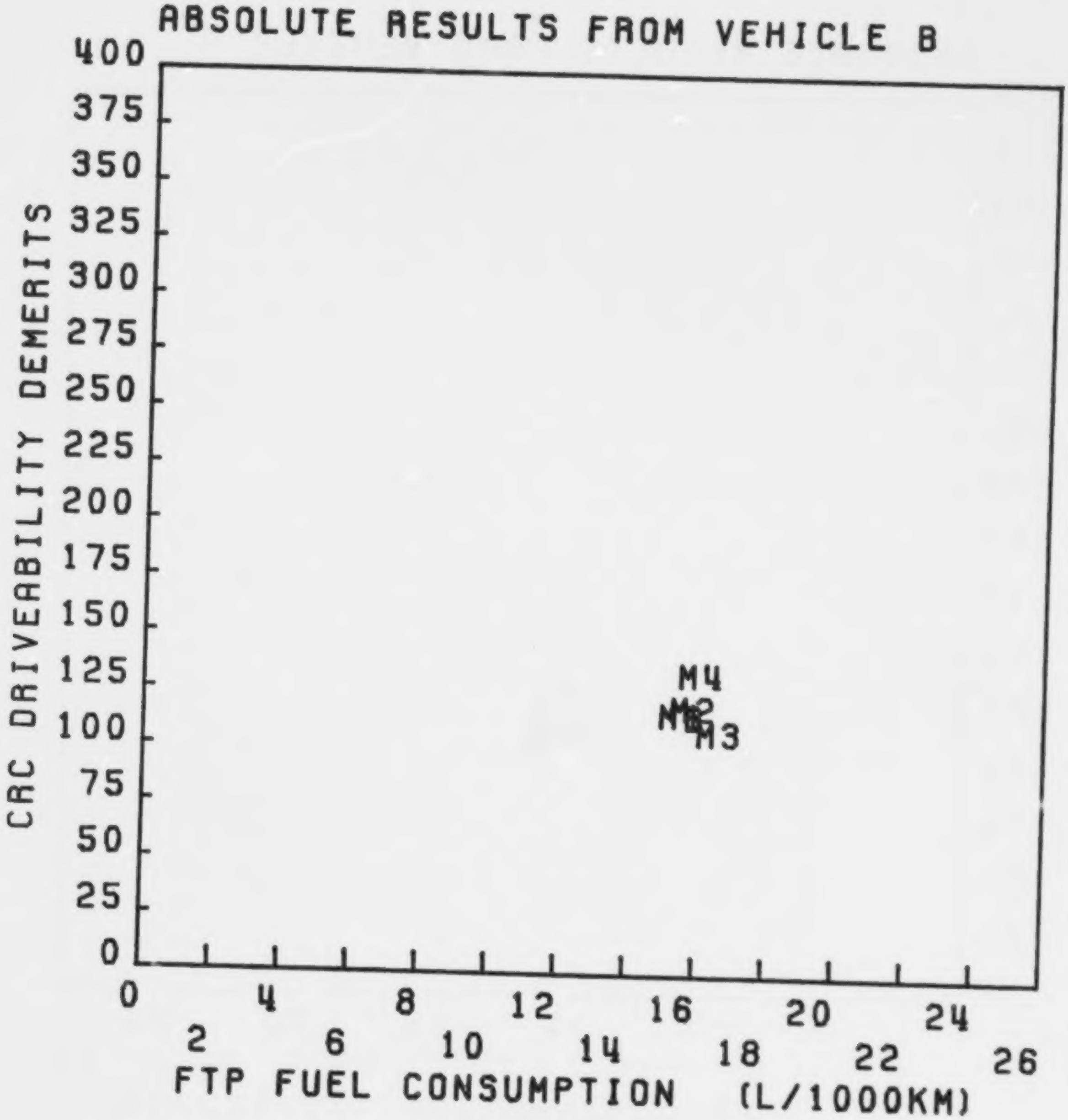

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M1
M4
M2
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)

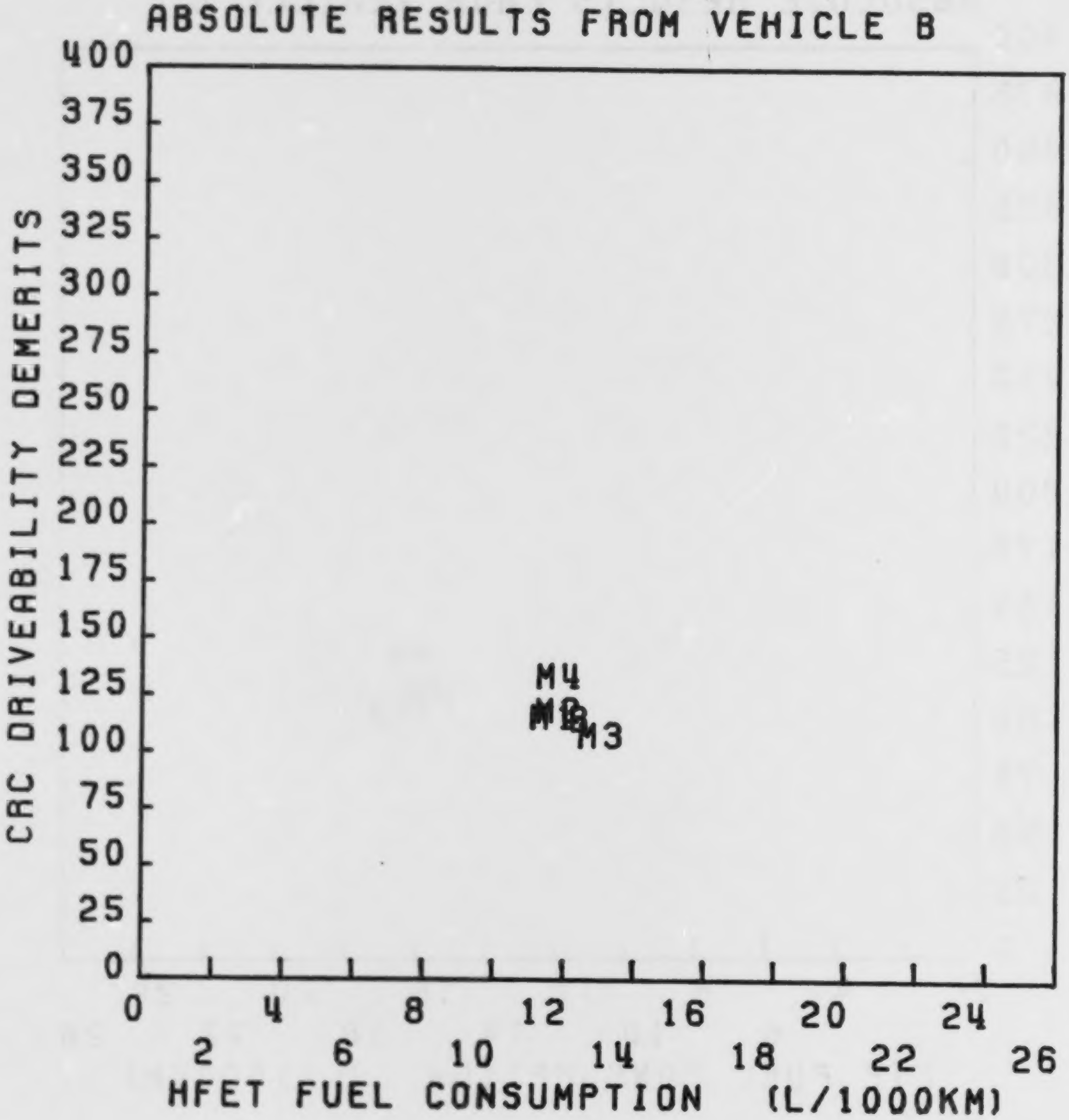

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M1
M4
M2
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

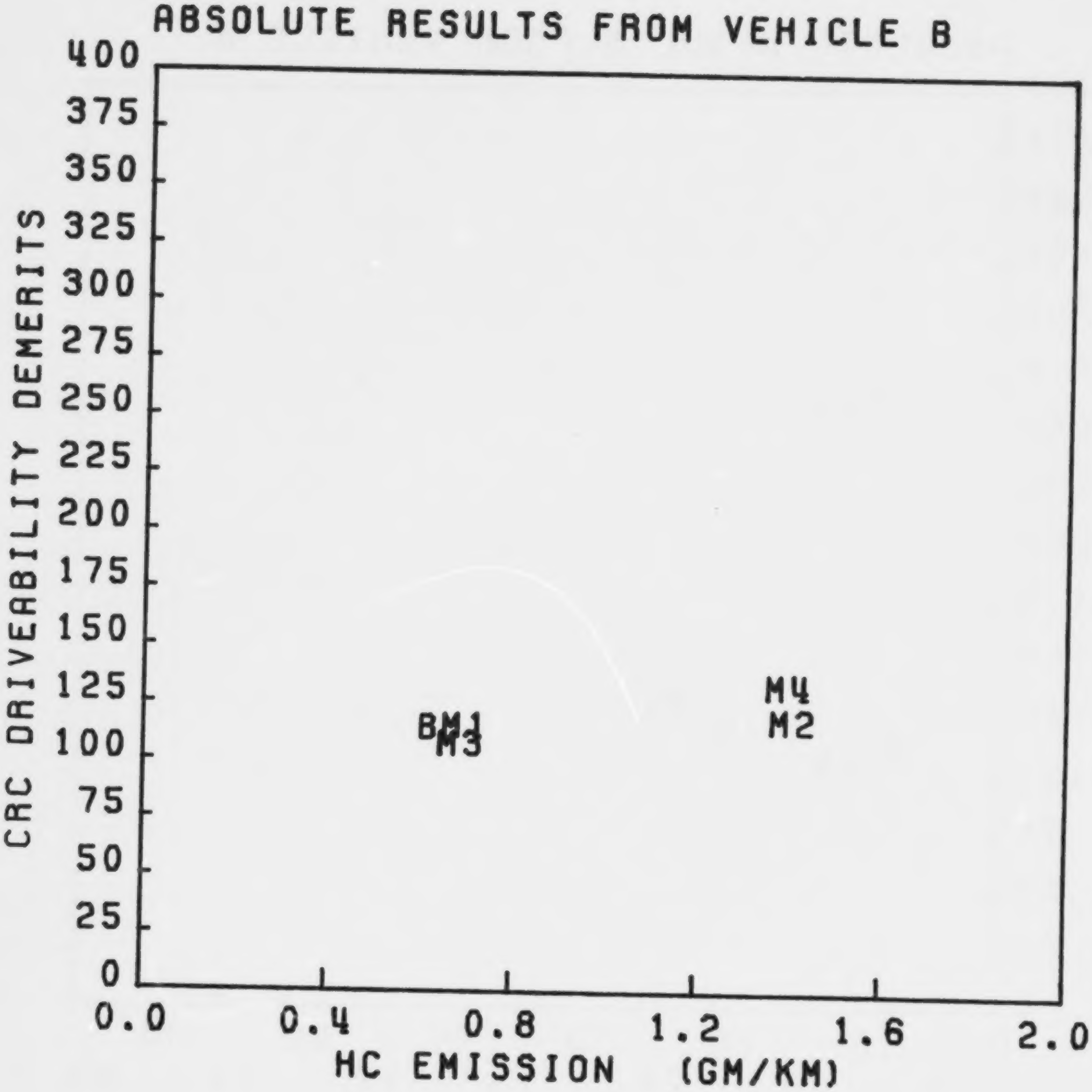

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M1
M4
M2
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)

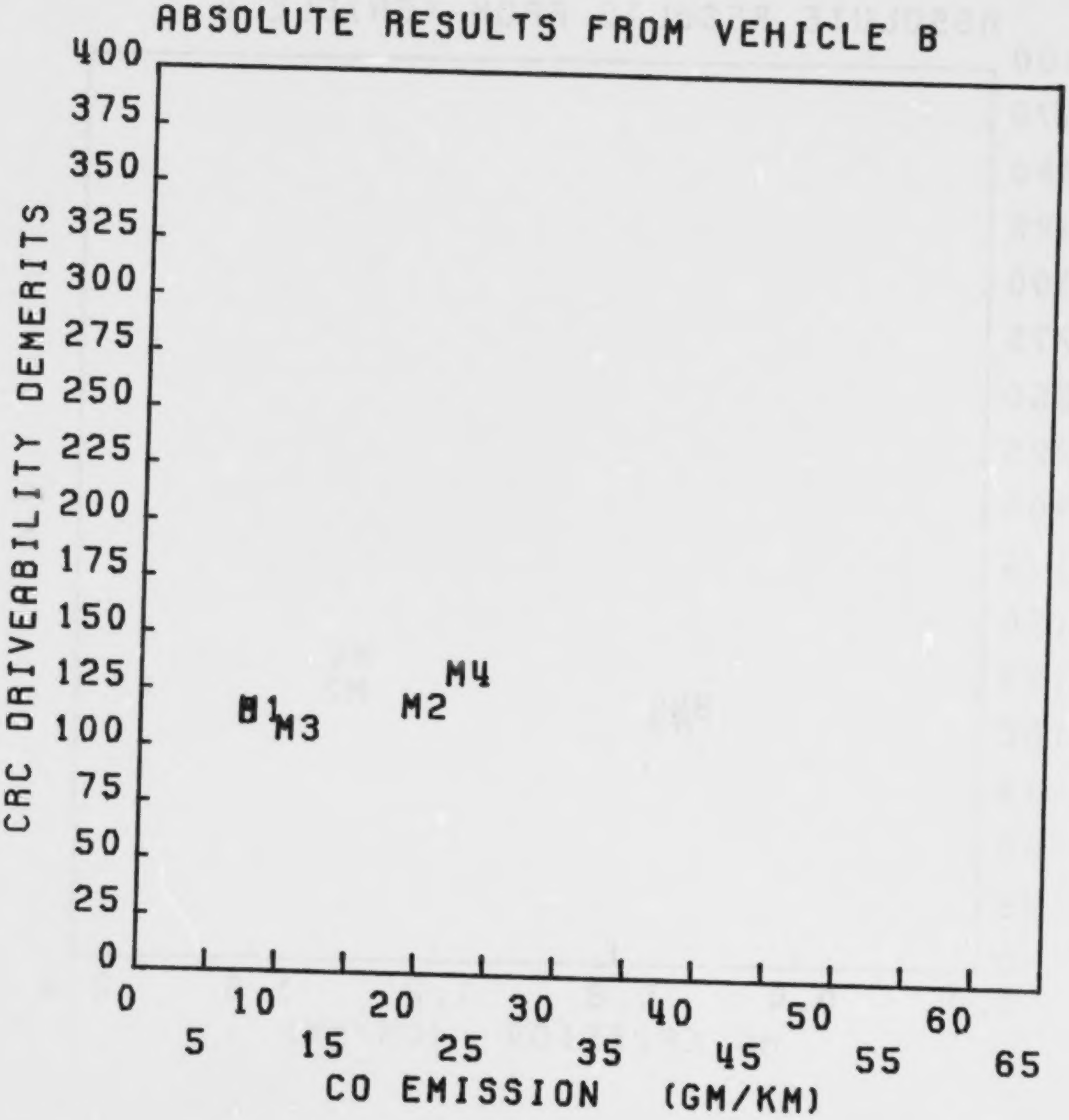
ABSOLUTE RESULTS FROM VEHICLE B

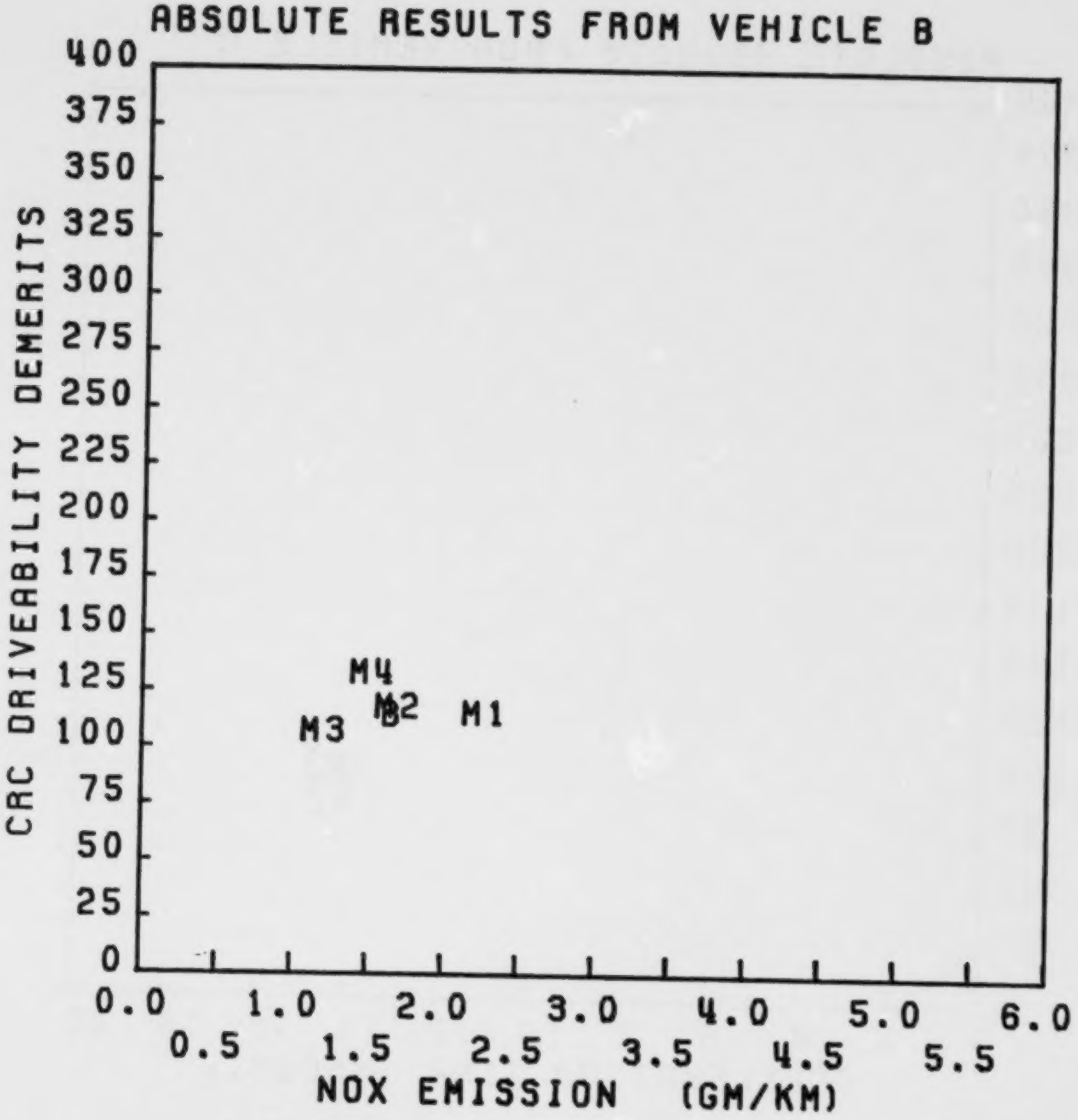



ABSOLUTE RESULTS FROM VEHICLE B
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
M4
M2
M3
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)

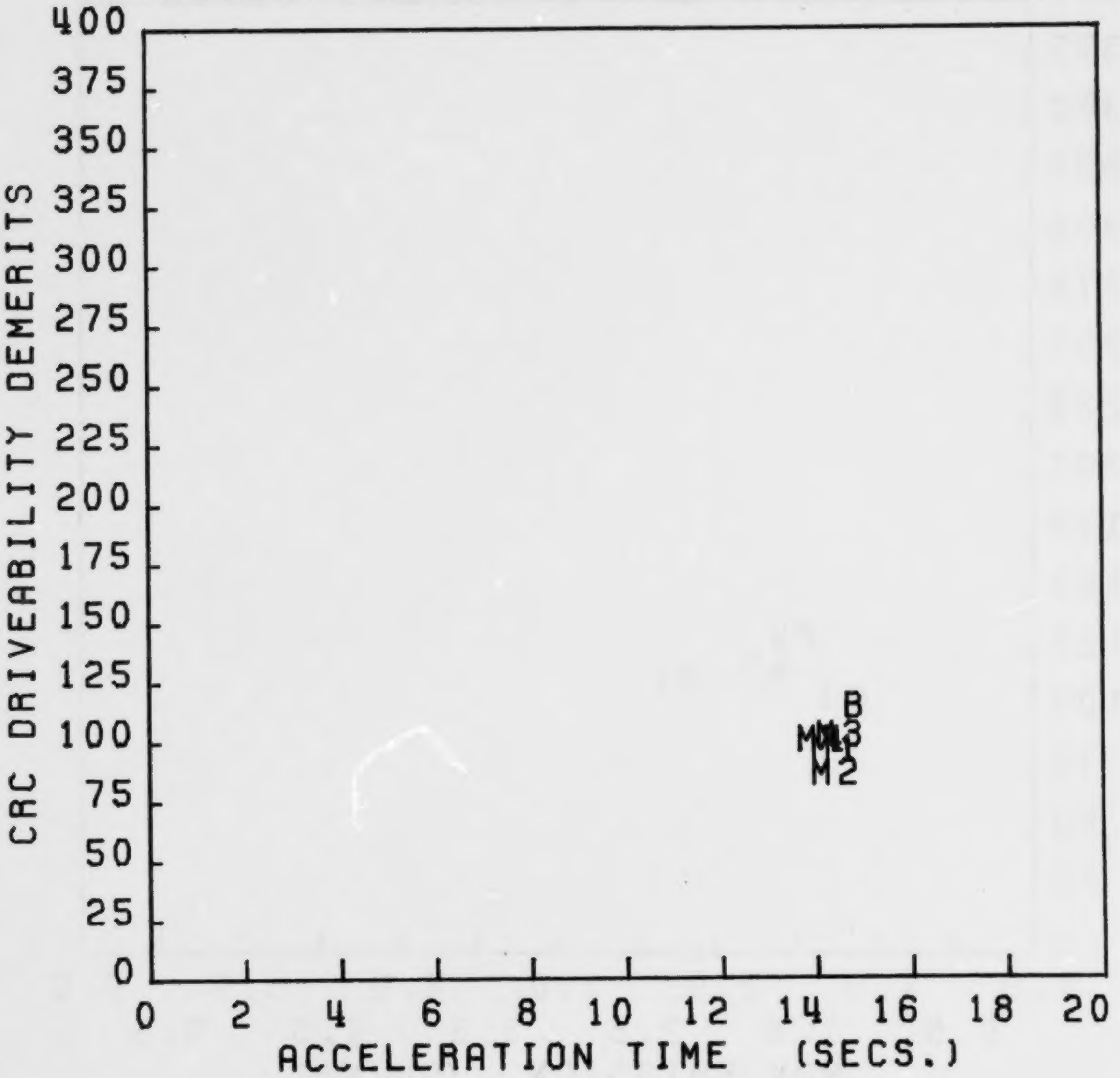

ABSOLUTE RESULTS FROM VEHICLE B
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
HFET FUEL CONSUMPTION (L/1000KM)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
M4
M2
M1
M3

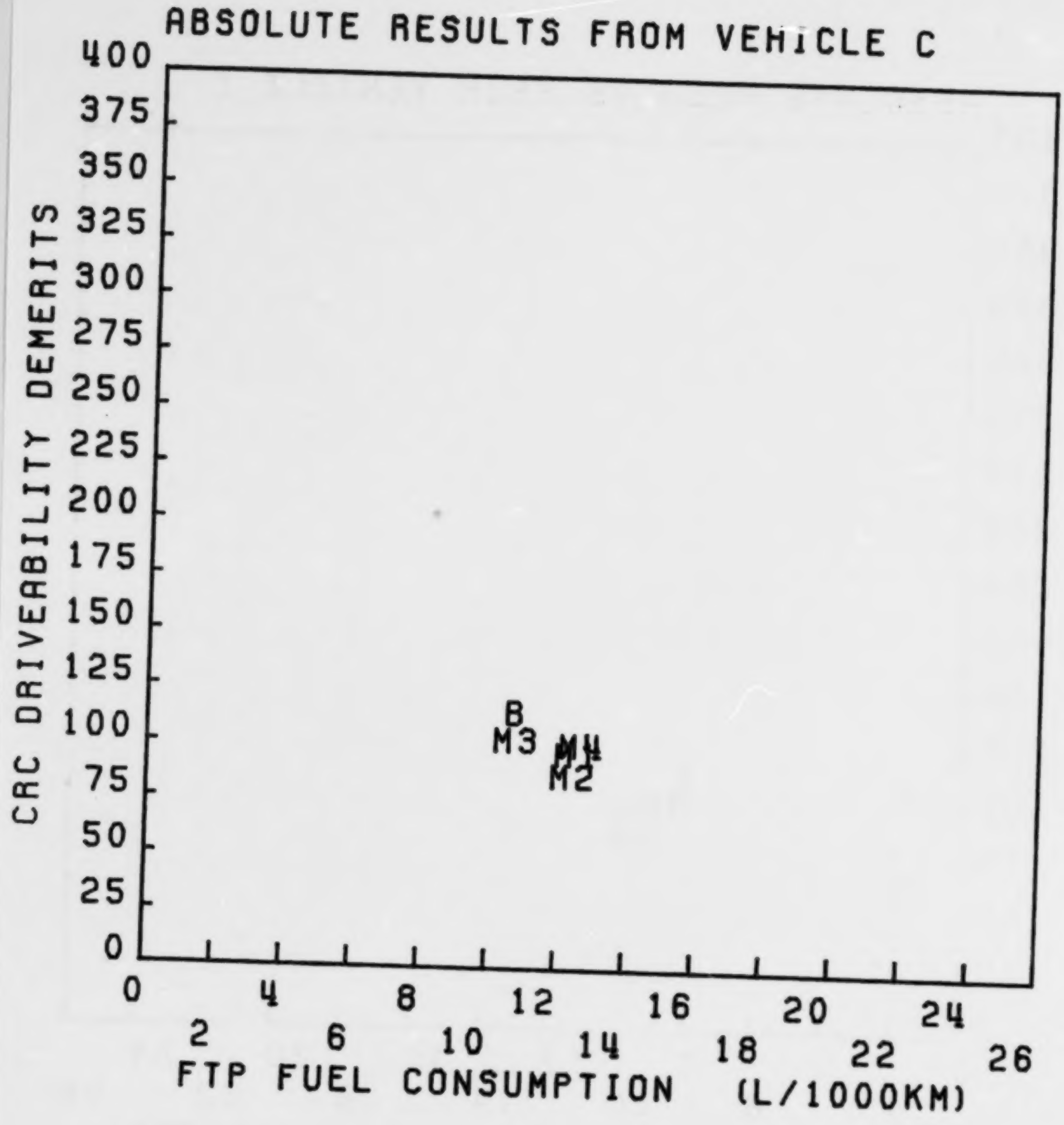

ABSOLUTE RESULTS FROM VEHICLE B
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
BM1
M3
M4
M2

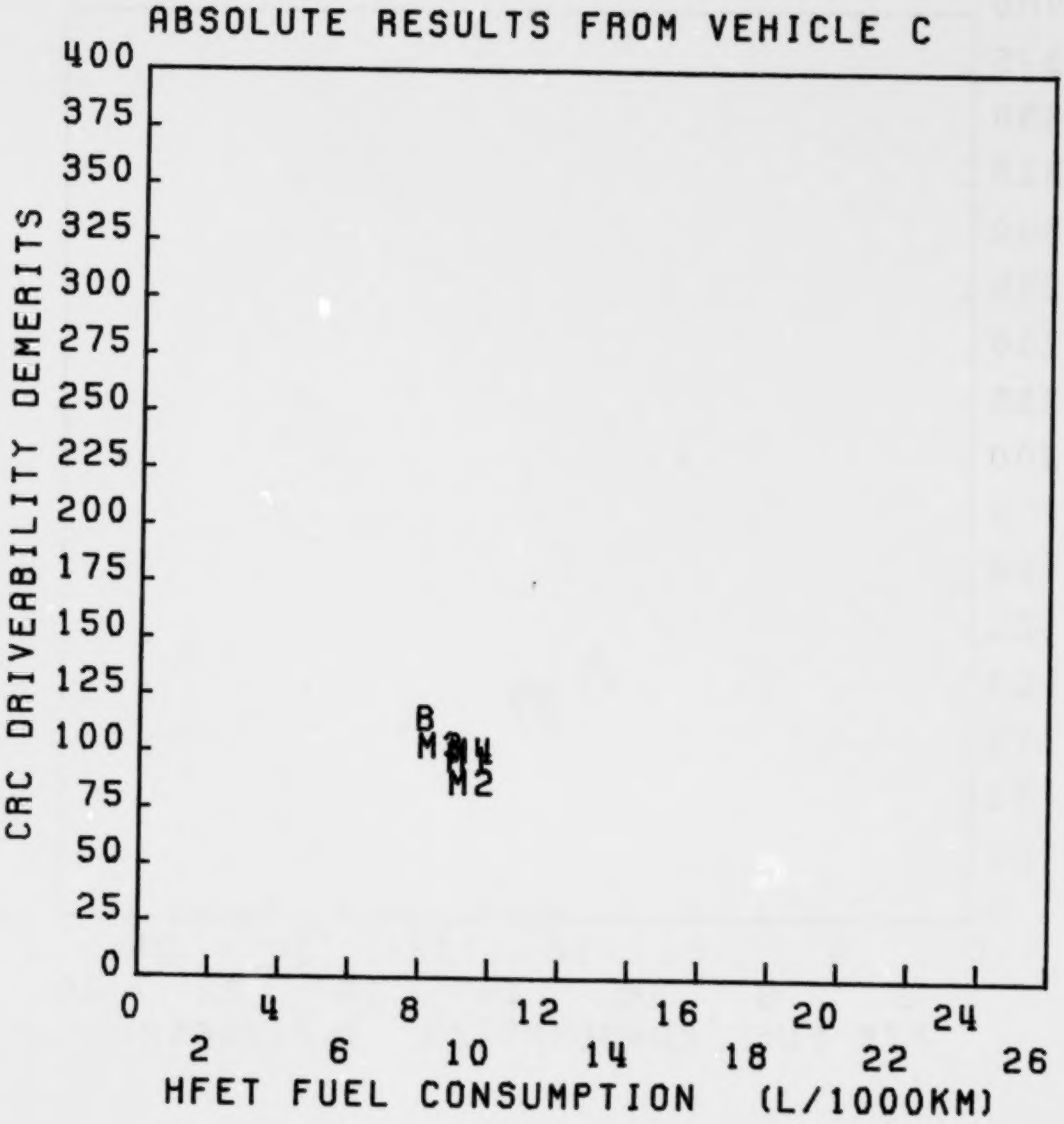

ABSOLUTE RESULTS FROM VEHICLE B
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
M1
M2
M3
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

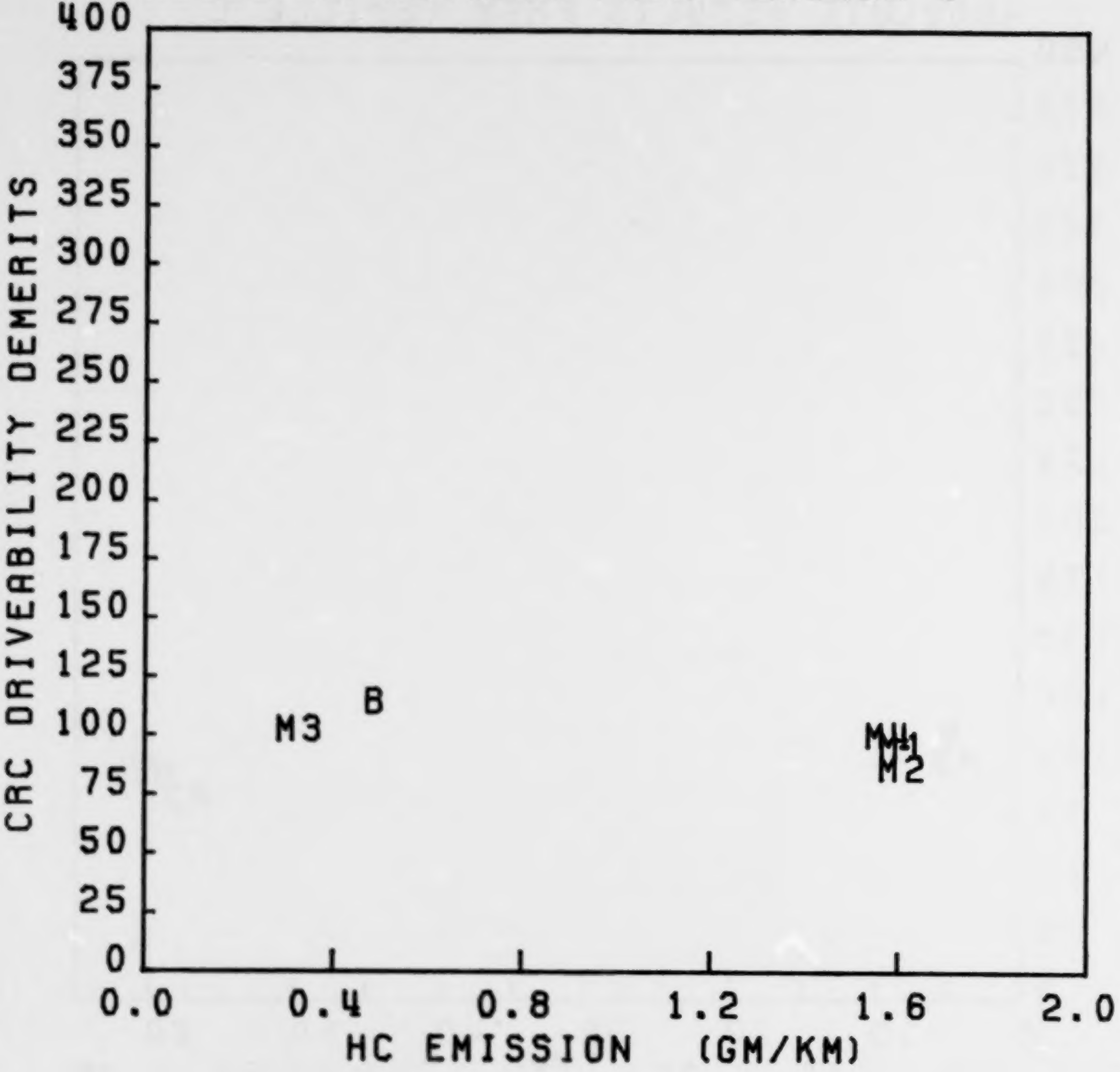

ABSOLUTE RESULTS FROM VEHICLE B
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
M2
B
M1
M3
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

ABSOLUTE RESULTS FROM VEHICLE C

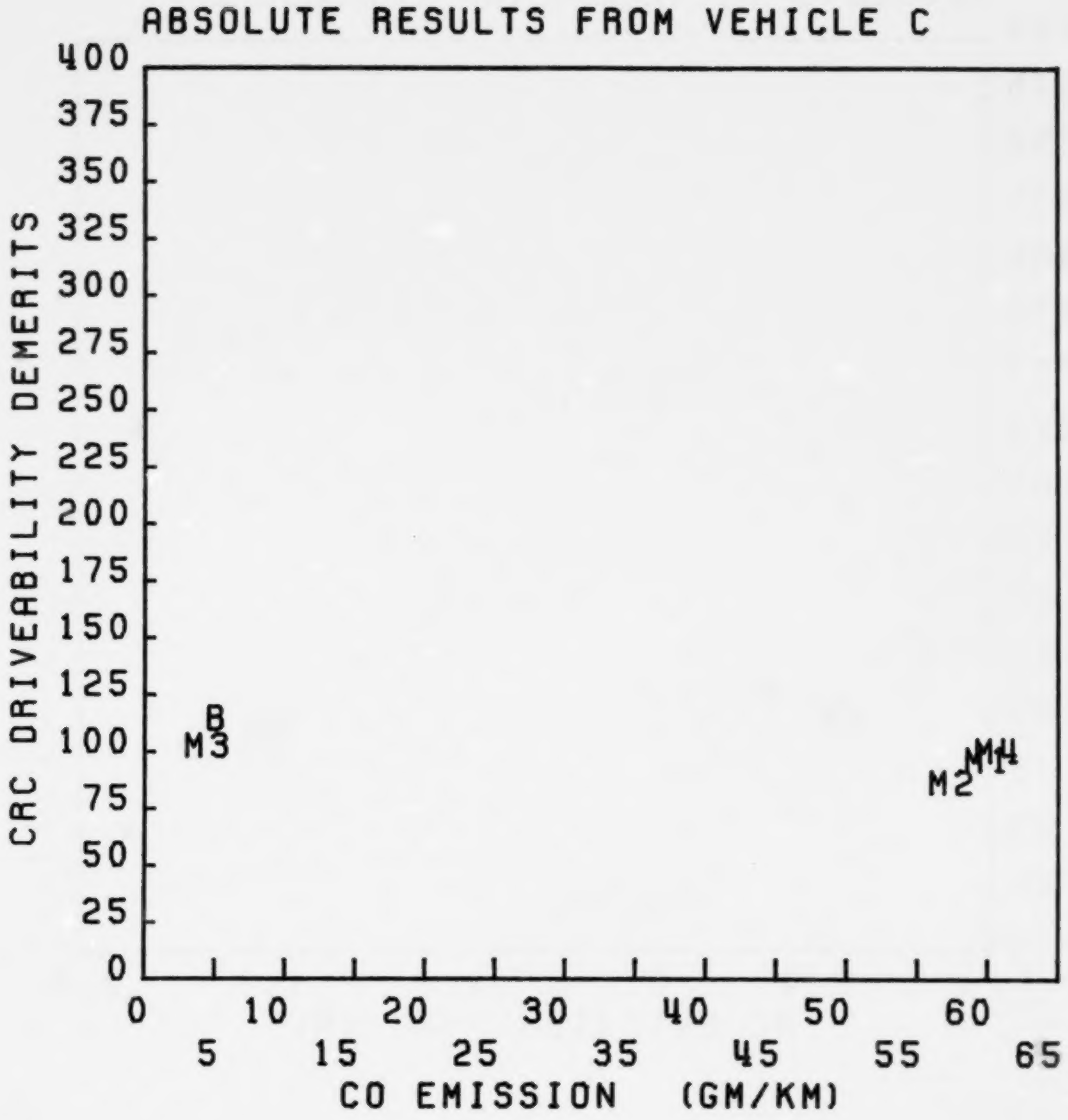



ABSOLUTE RESULTS FROM VEHICLE C
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M4
M1
M2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)

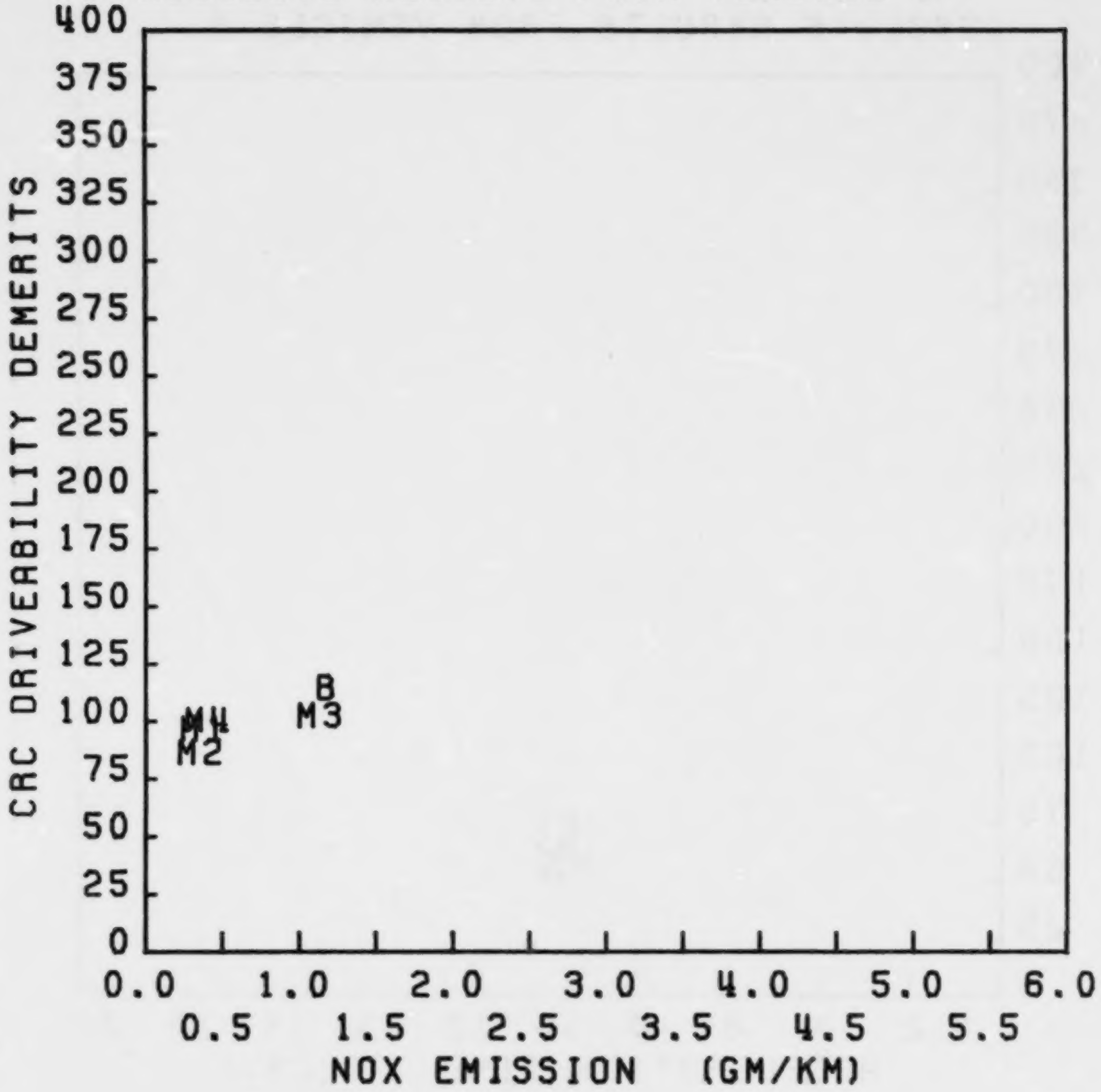

ABSOLUTE RESULTS FROM VEHICLE C
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
HFET FUEL CONSUMPTION (L/1000KM)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
B
M3
M4
M2



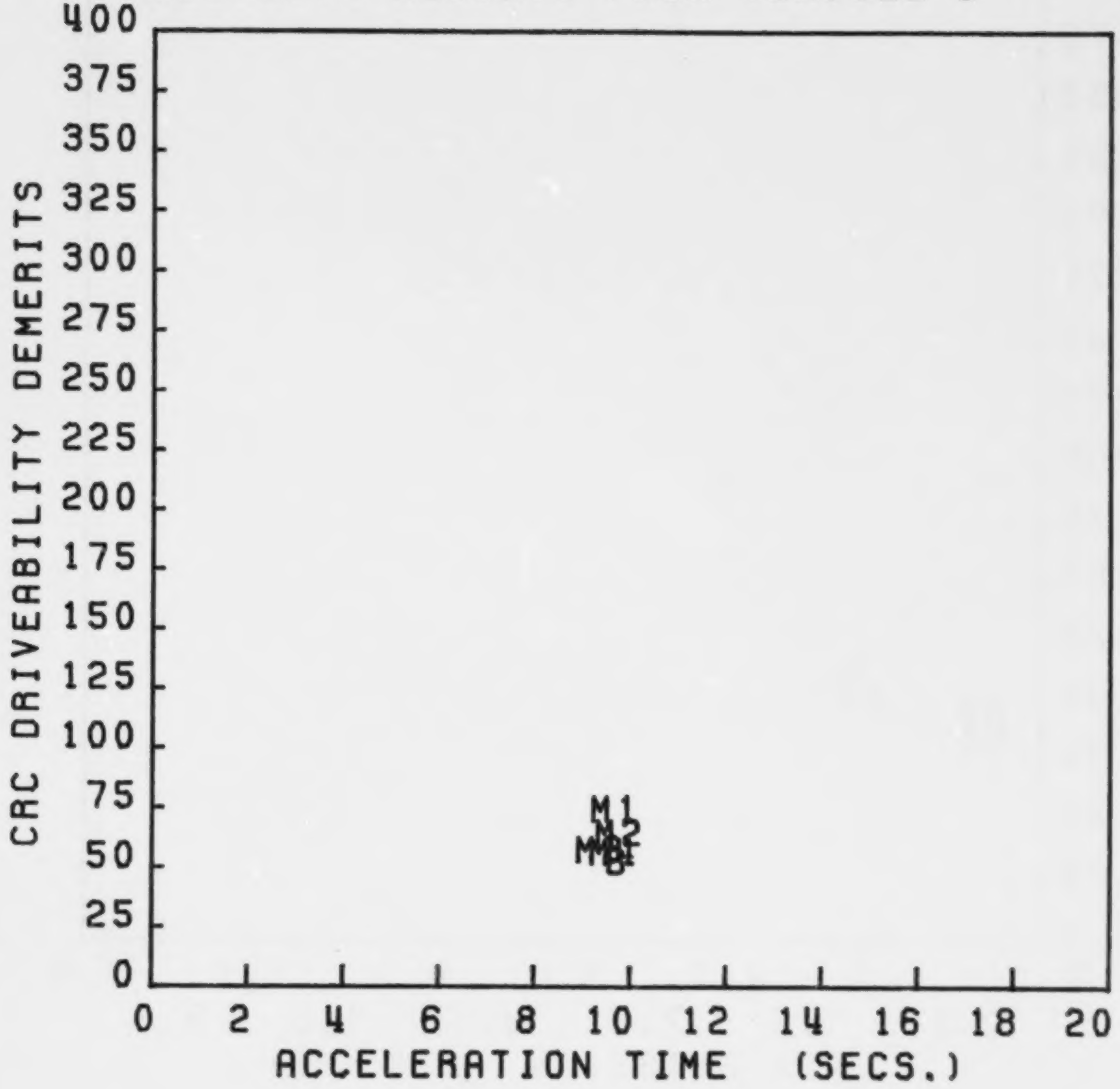
ABSOLUTE RESULTS FROM VEHICLE C

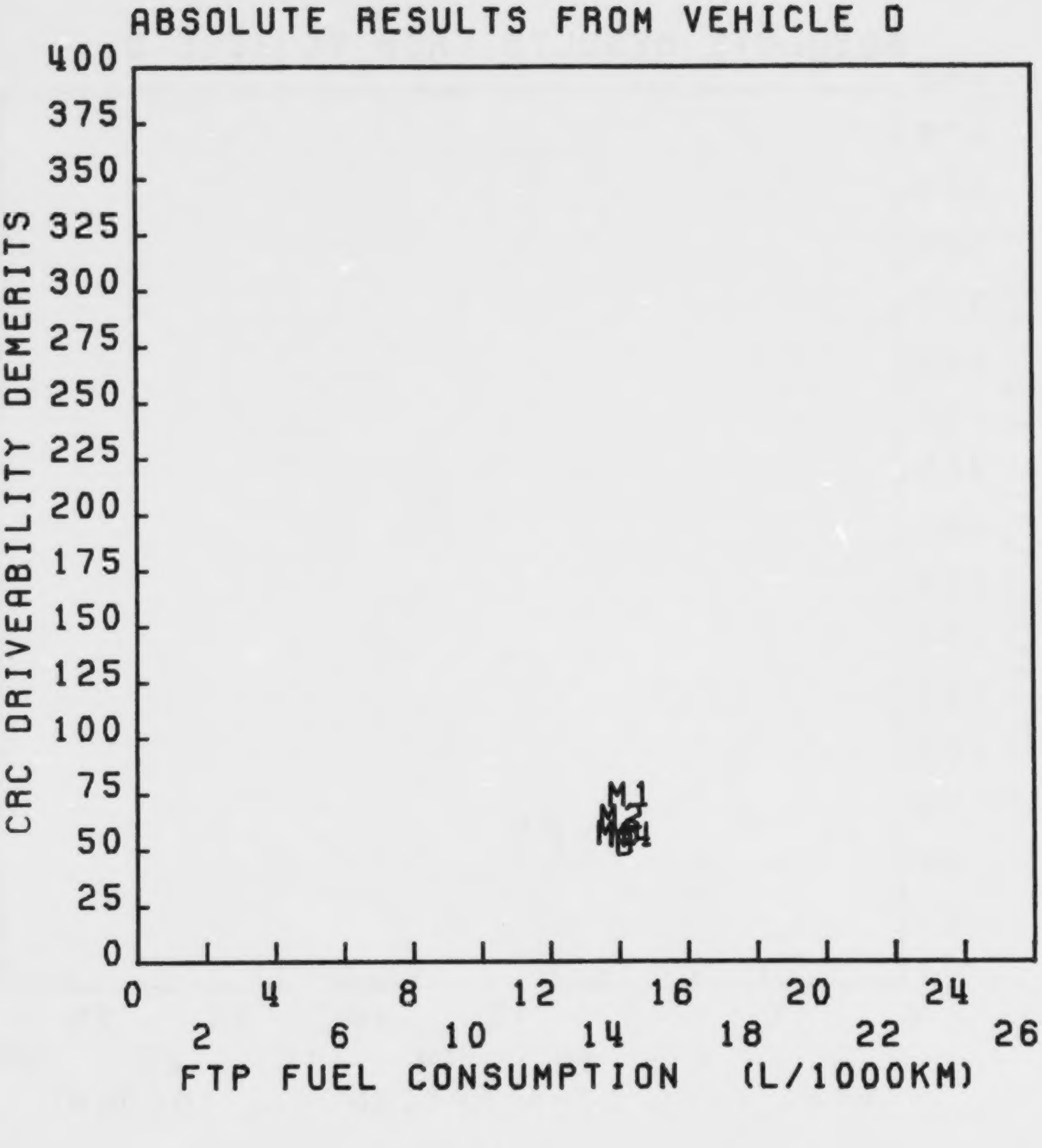

ABSOLUTE RESULTS FROM VEHICLE C
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M2
M1
M4
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

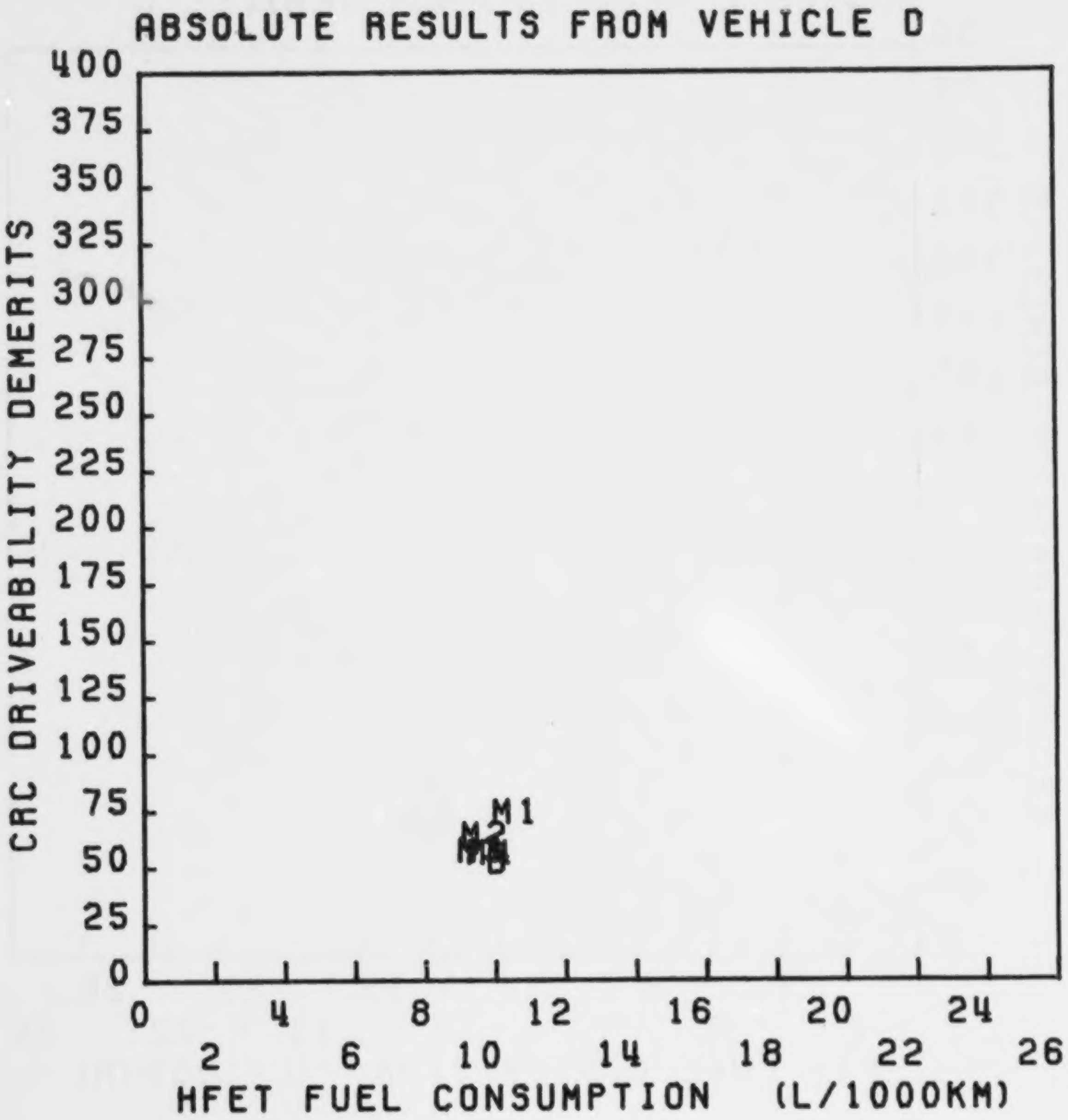
ABSOLUTE RESULTS FROM VEHICLE C

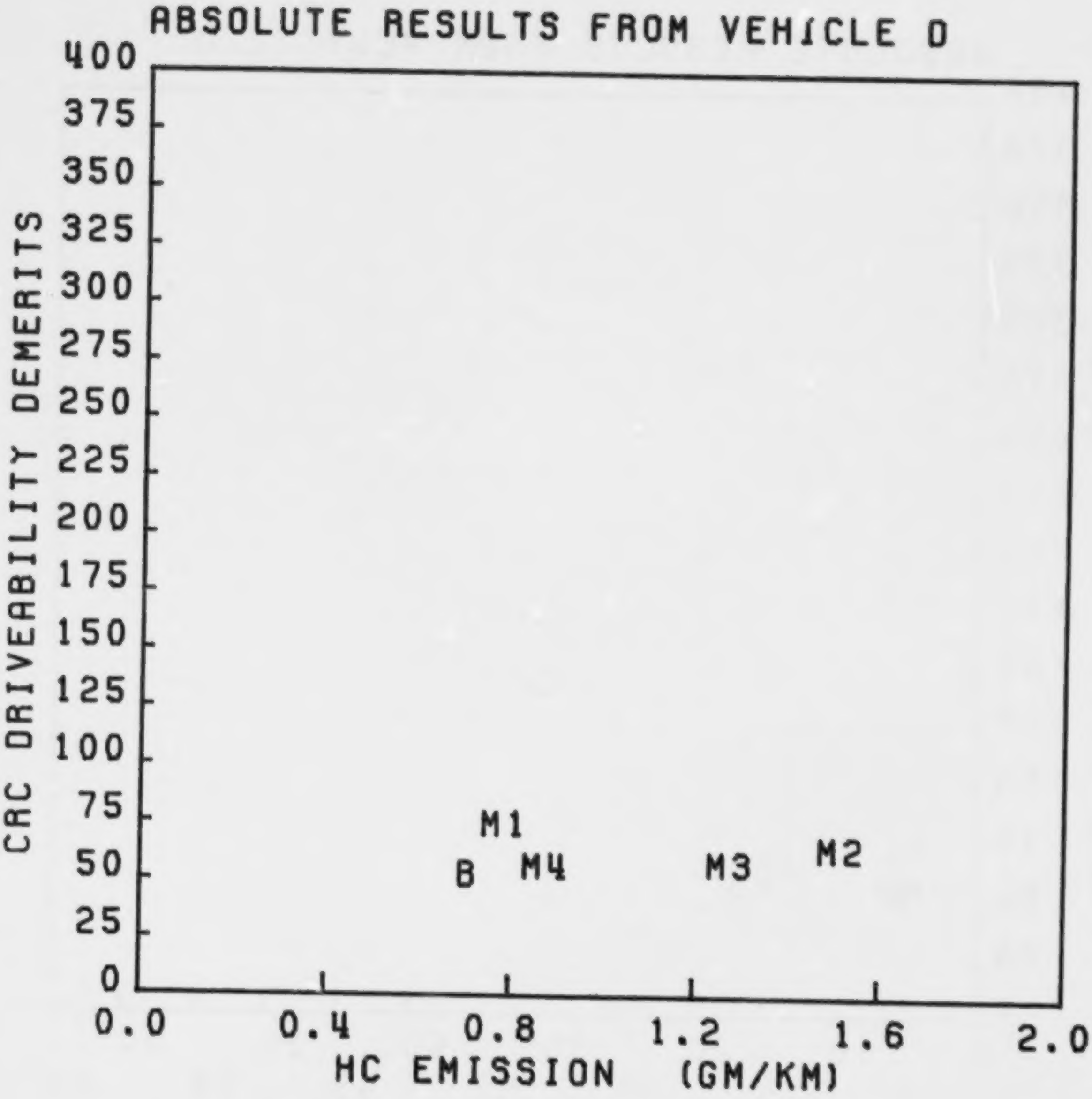


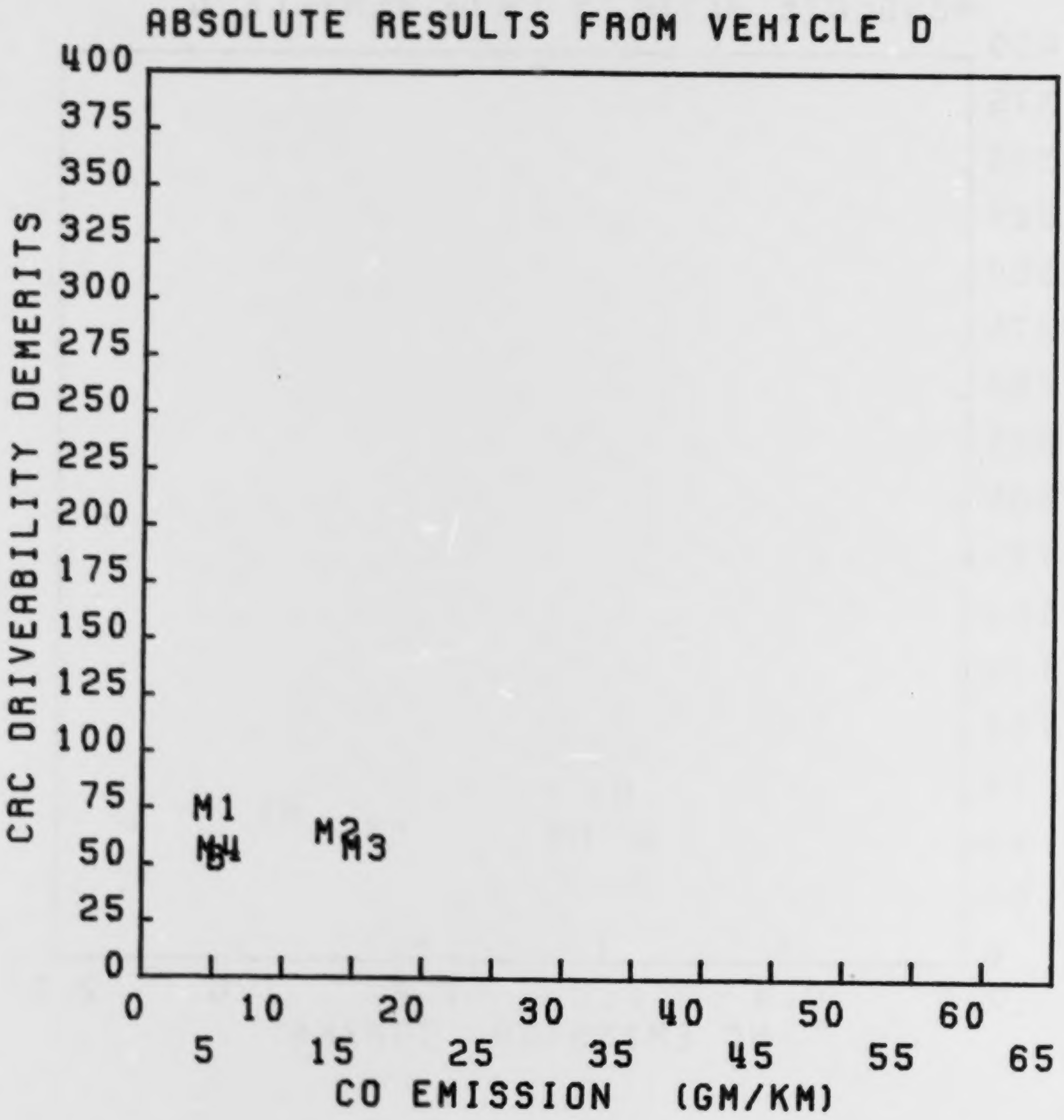
ABSOLUTE RESULTS FROM VEHICLE D

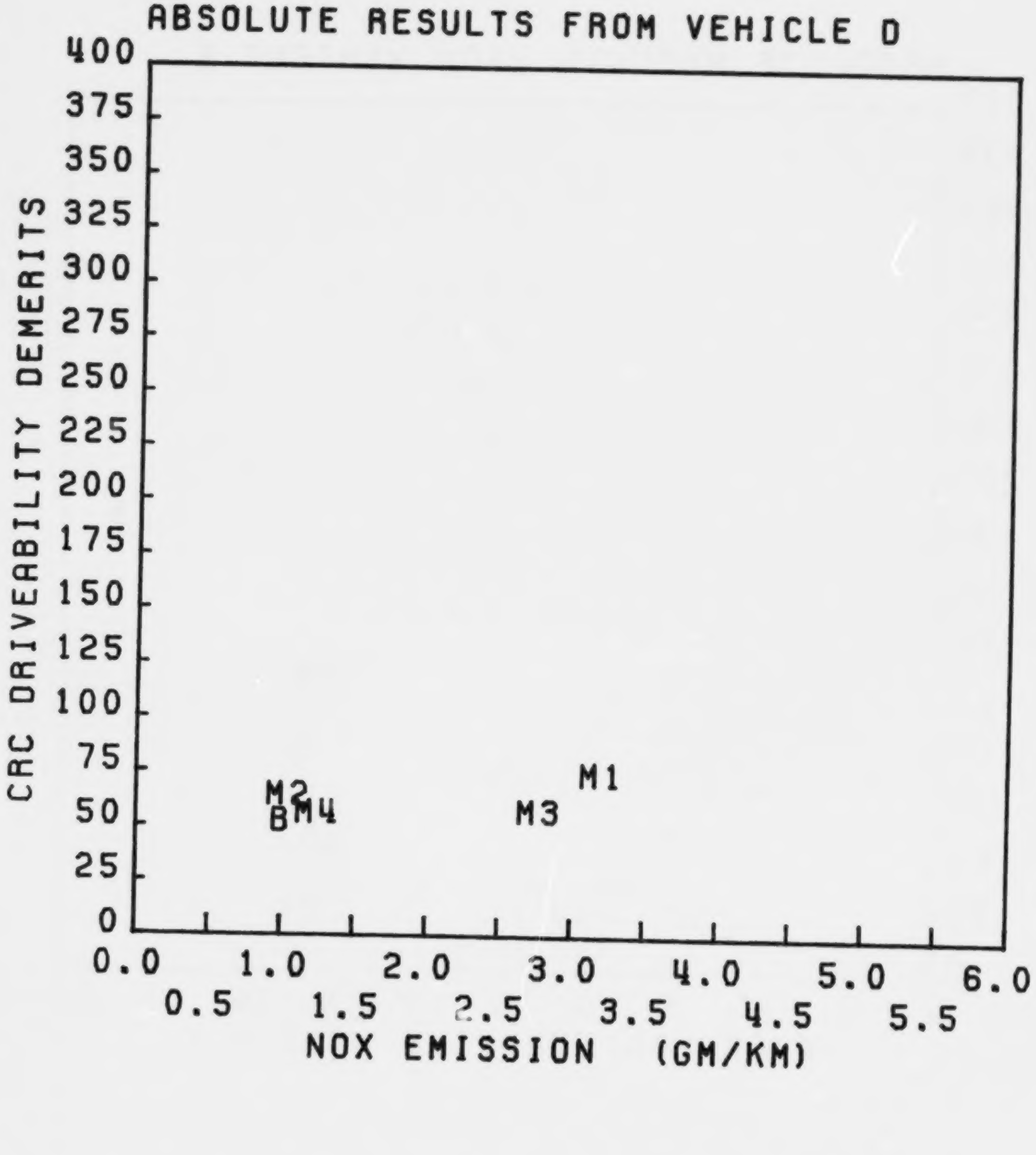


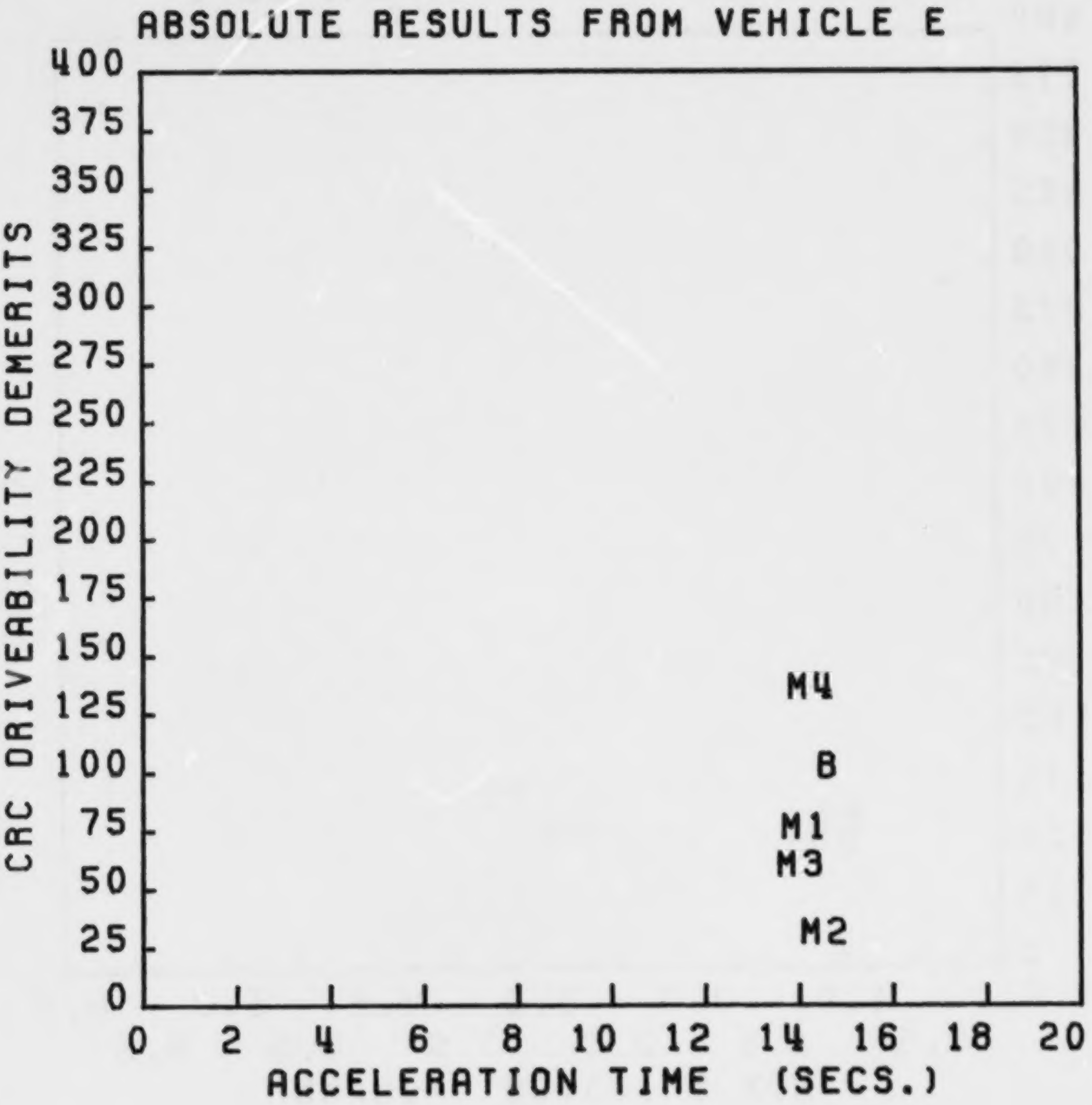

ABSOLUTE RESULTS FROM VEHICLE D
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1
M2
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)

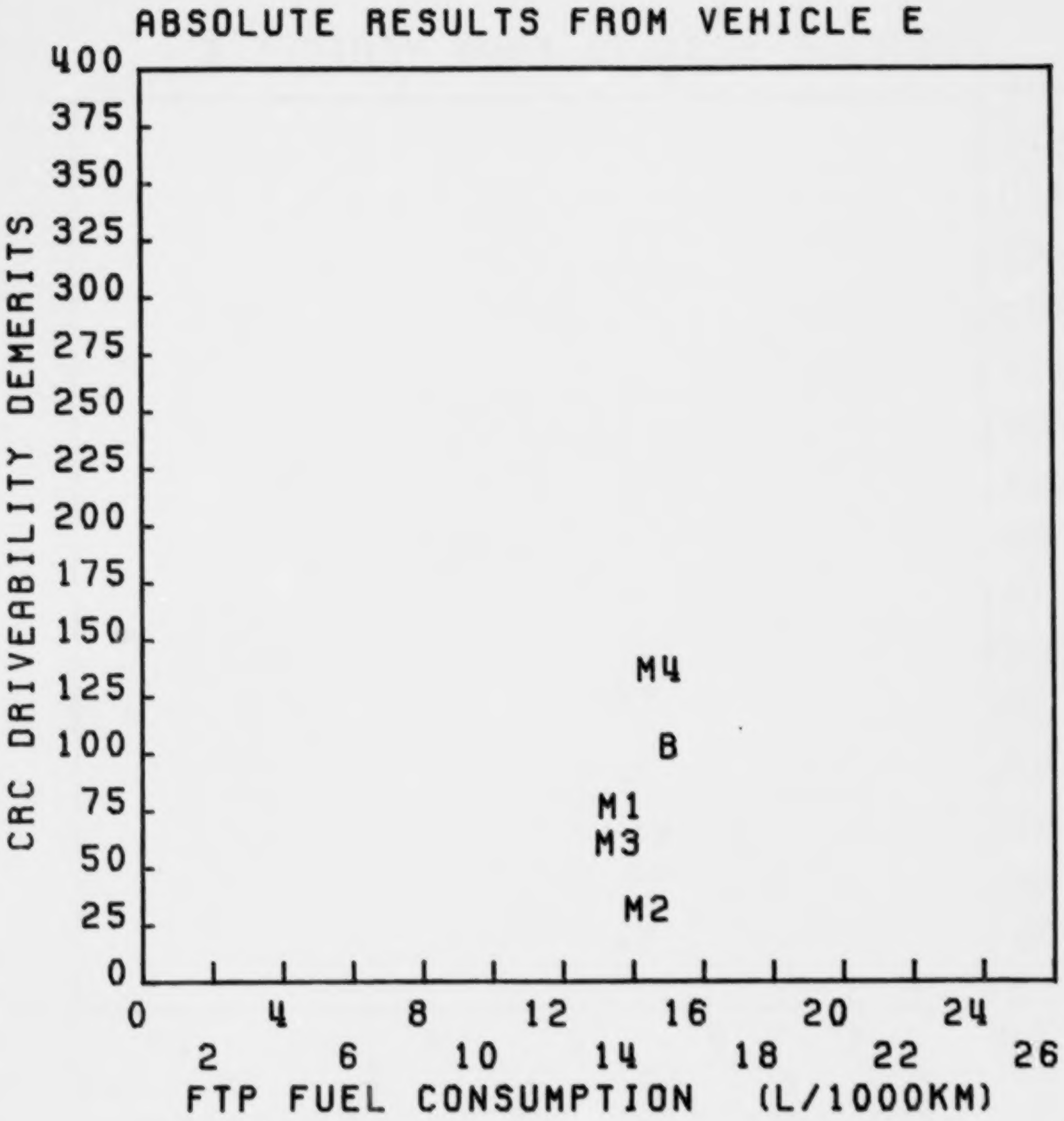

ABSOLUTE RESULTS FROM VEHICLE D
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
HFET FUEL CONSUMPTION (L/1000KM)
M1
M2
B

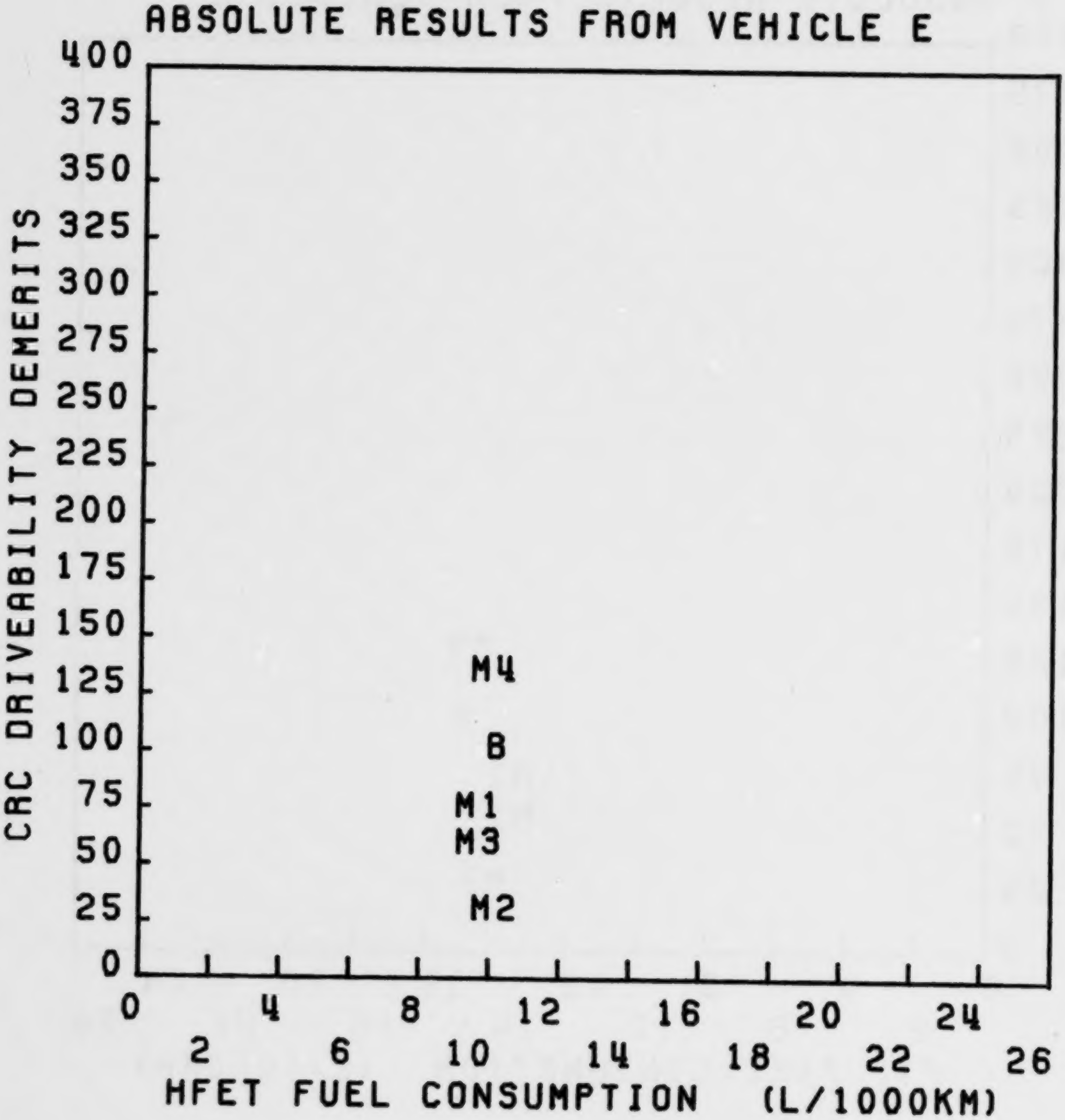

ABSOLUTE RESULTS FROM VEHICLE D
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M1
B
M4
M3
M2

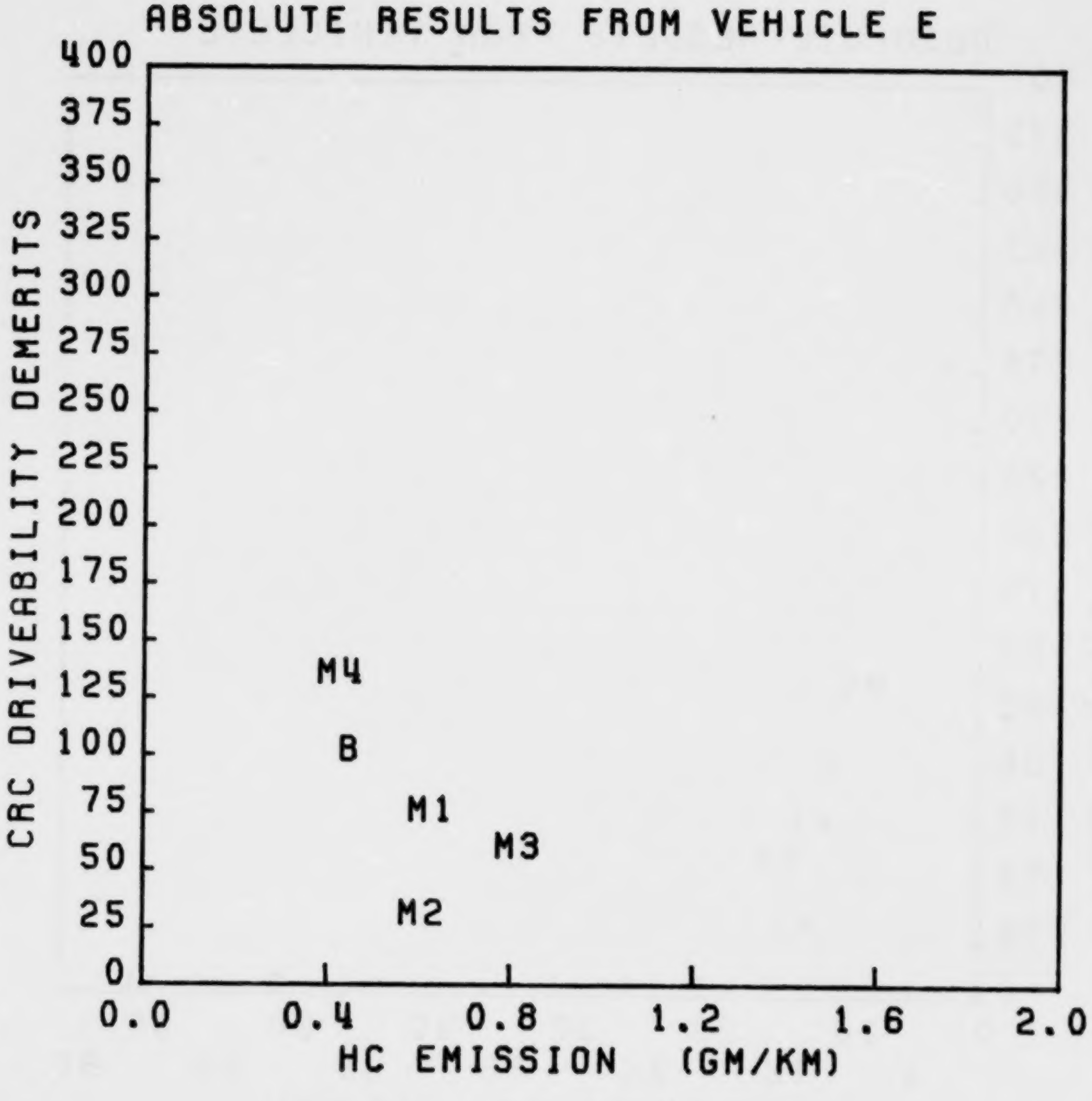

ABSOLUTE RESULTS FROM VEHICLE D
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1
M4
B1
M2
M3
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

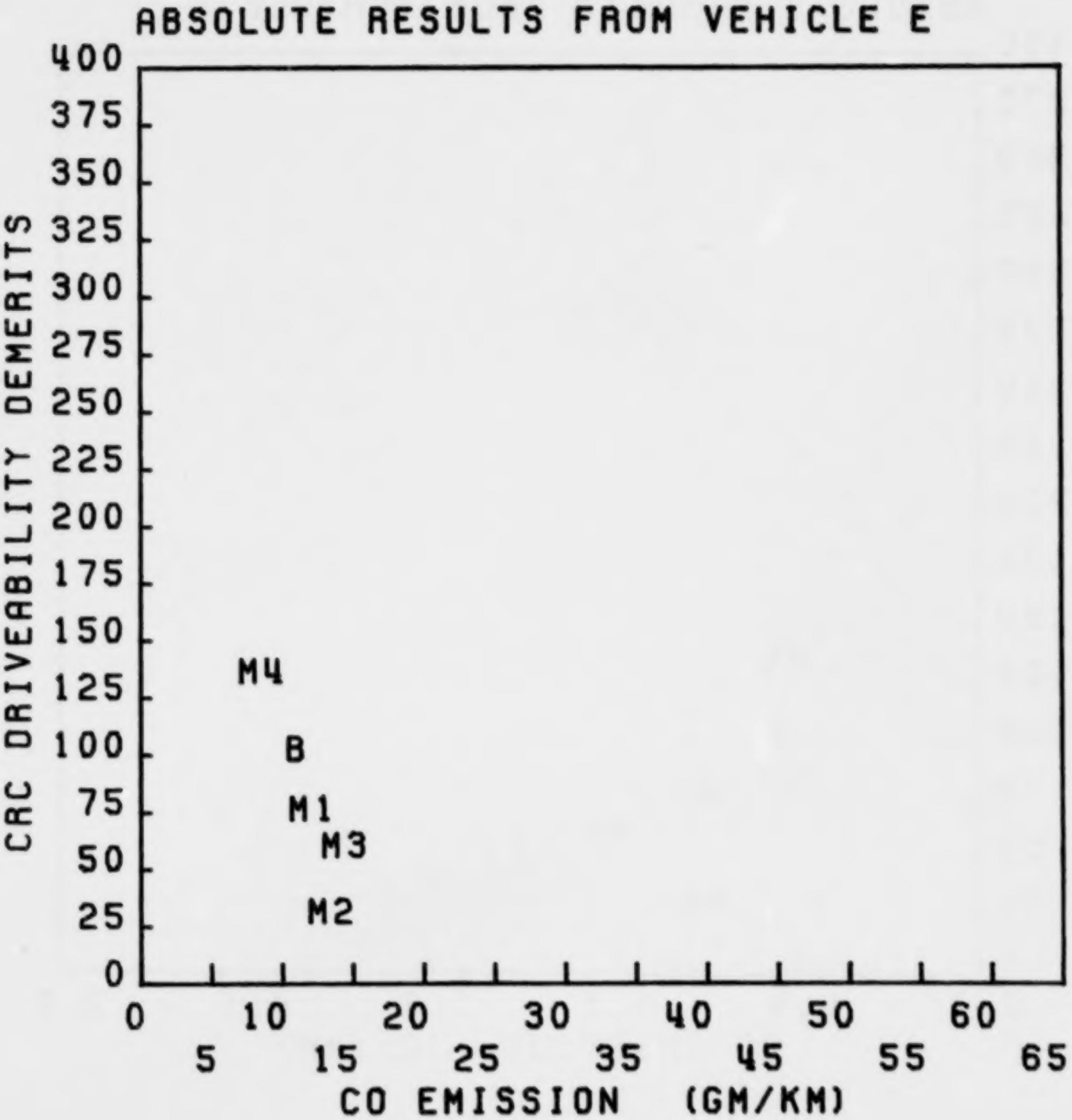

ABSOLUTE RESULTS FROM VEHICLE D
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)
M1
M2
B
M4
M3

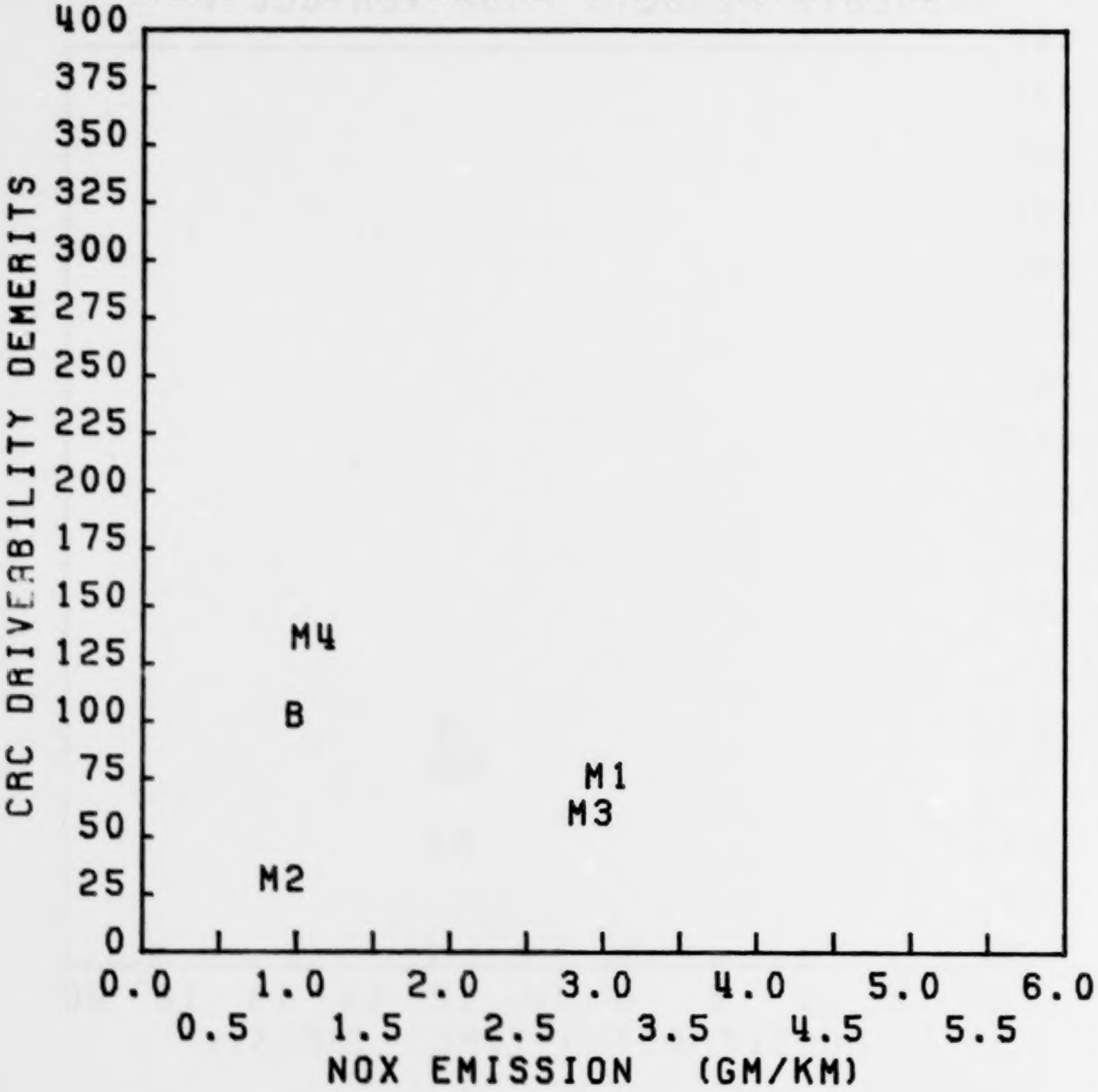
ABSOLUTE RESULTS FROM VEHICLE E
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M1
M3
M2
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)


ABSOLUTE RESULTS FROM VEHICLE E
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)
M4
B
M1
M3
M2

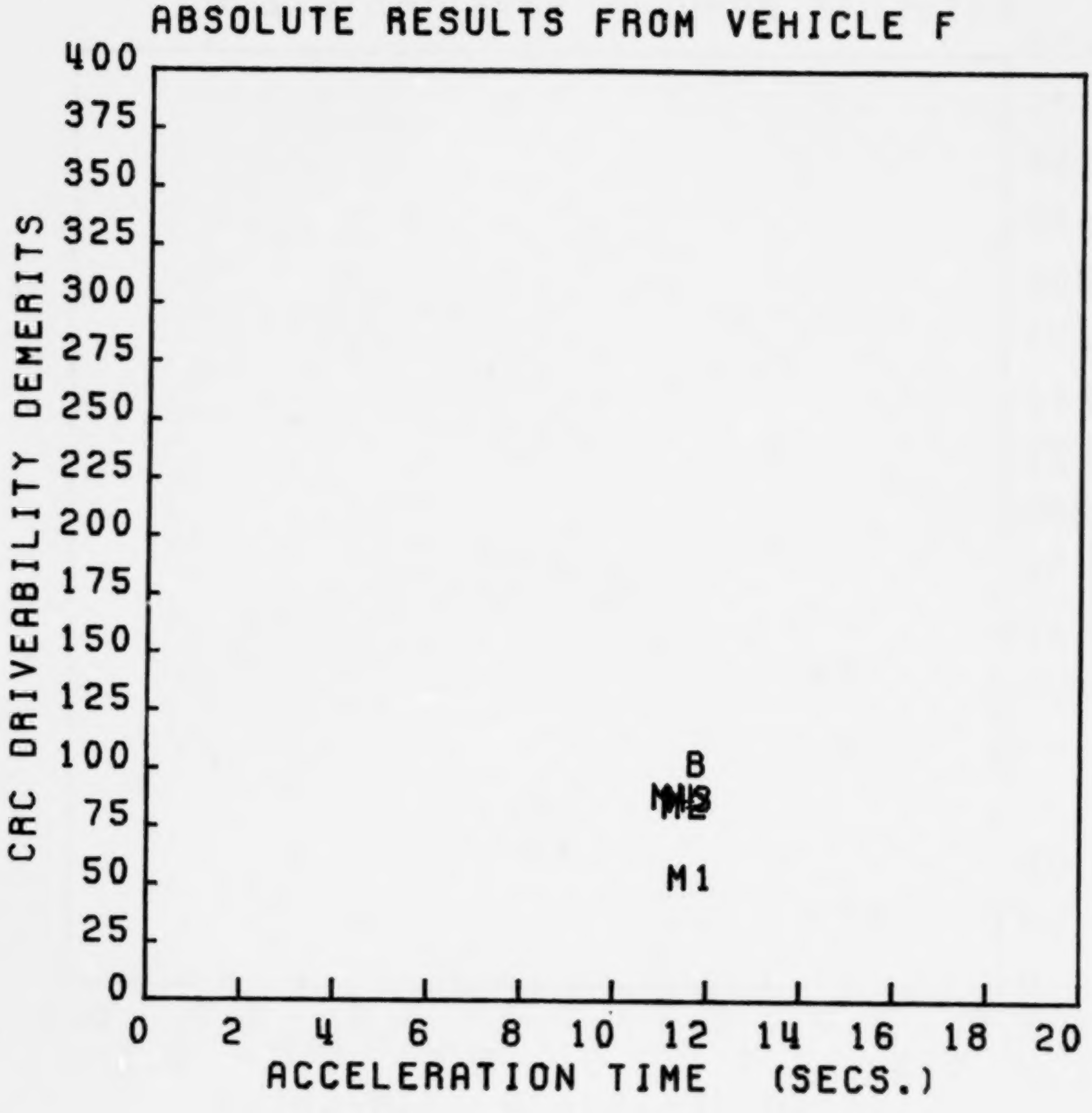

ABSOLUTE RESULTS FROM VEHICLE E
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M1
M3
M2
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

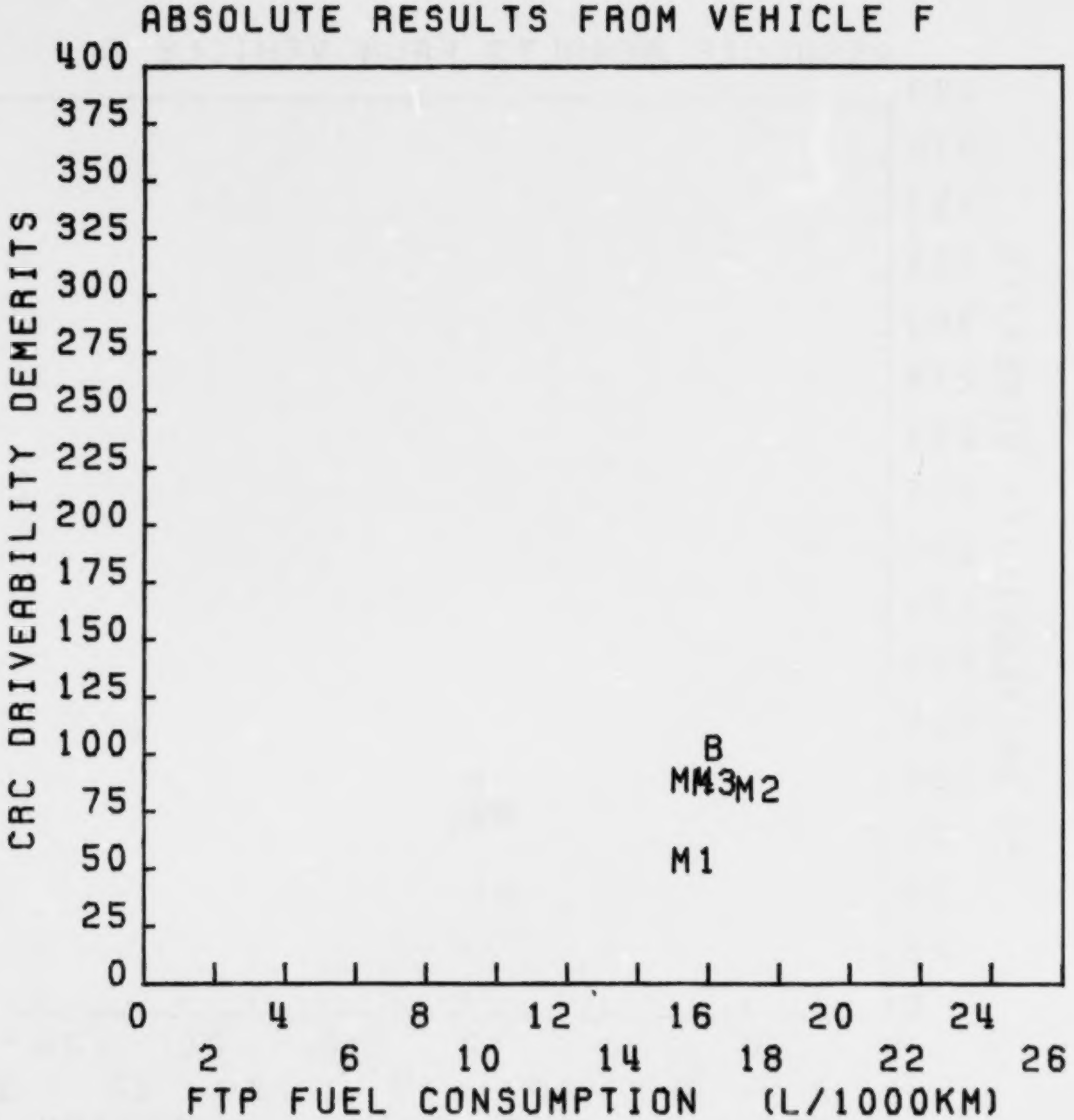

ABSOLUTE RESULTS FROM VEHICLE E
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M4
B
M1
M3
M2

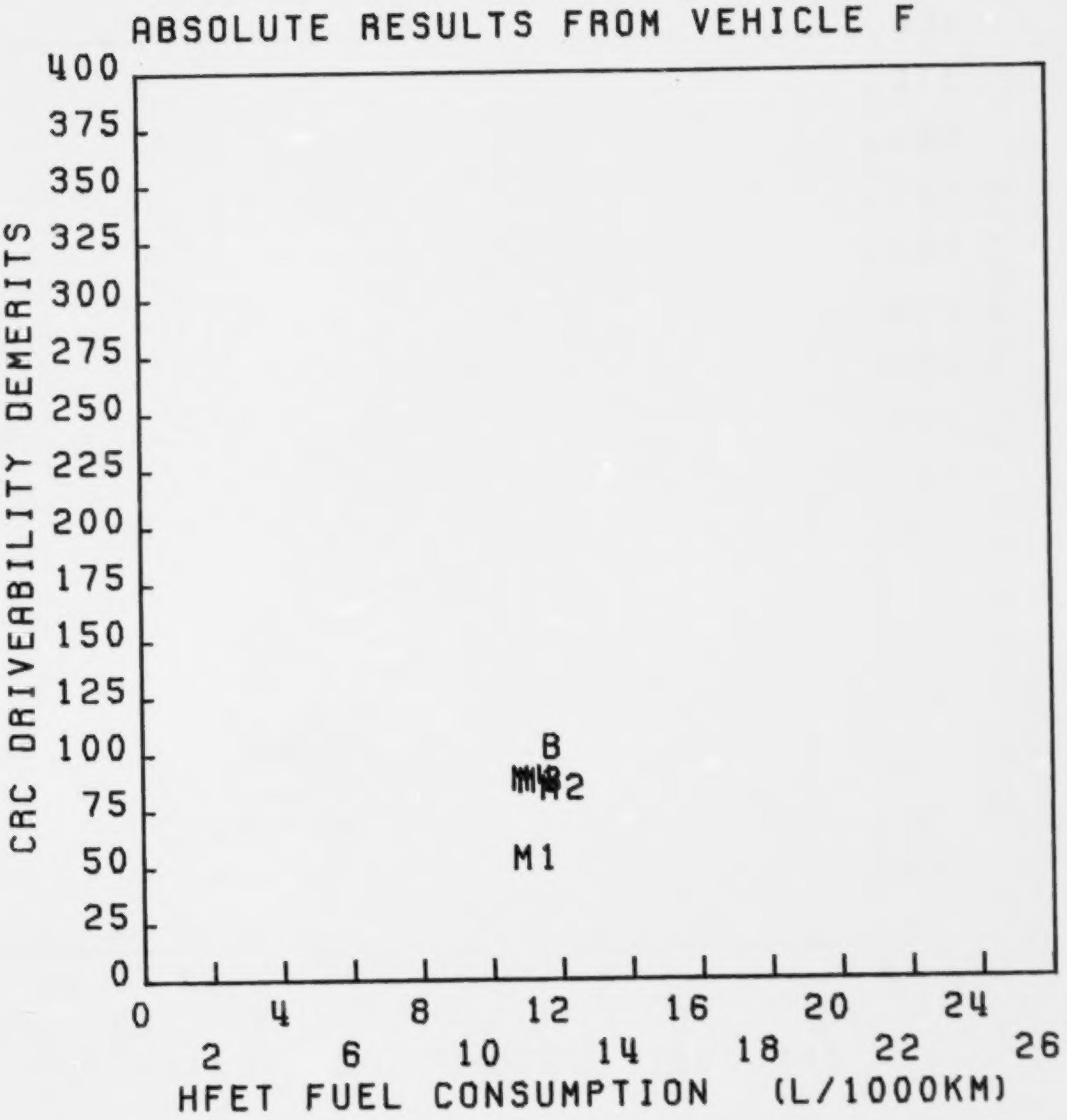

ABSOLUTE RESULTS FROM VEHICLE E
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M1
M3
M2
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

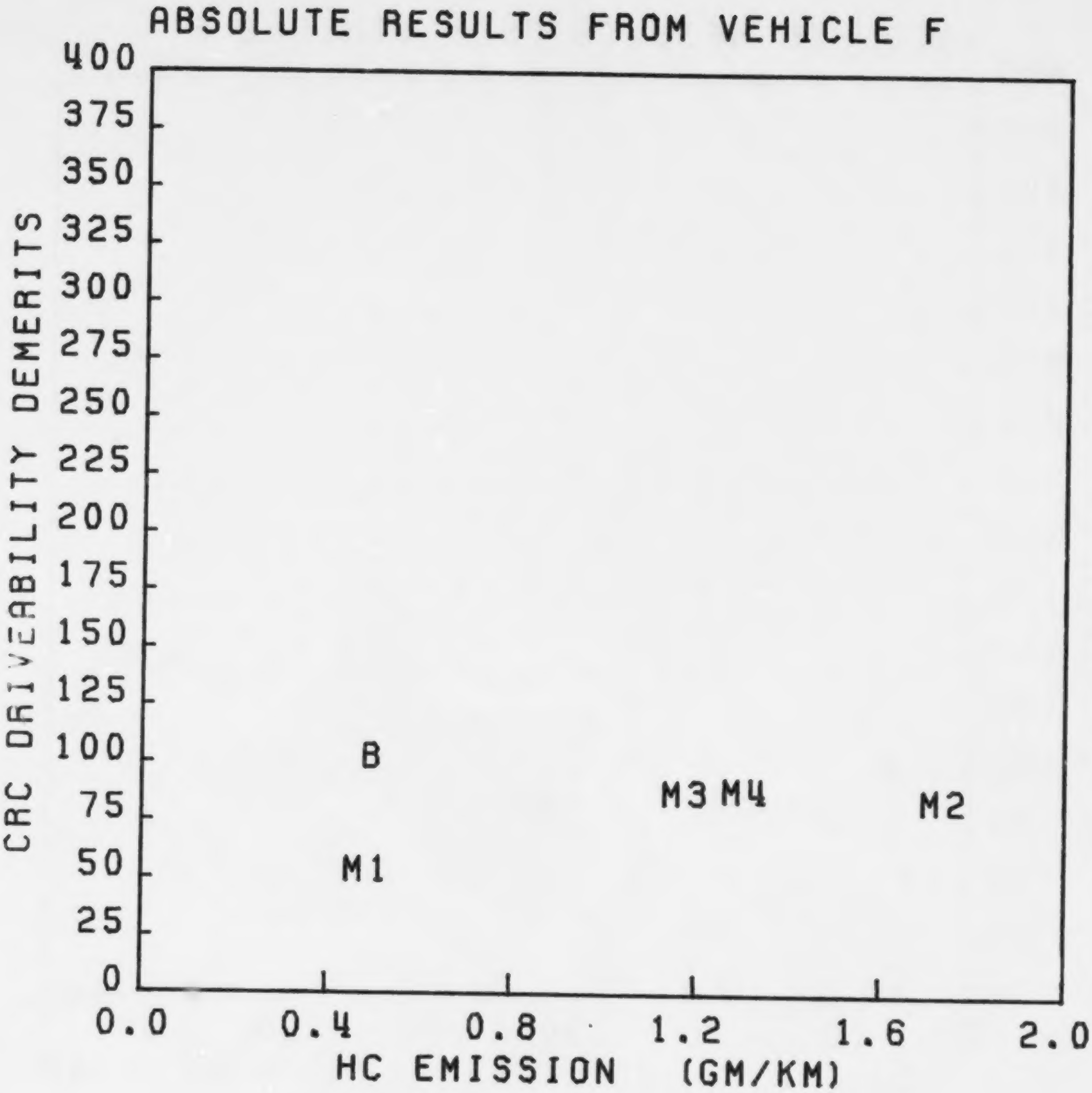


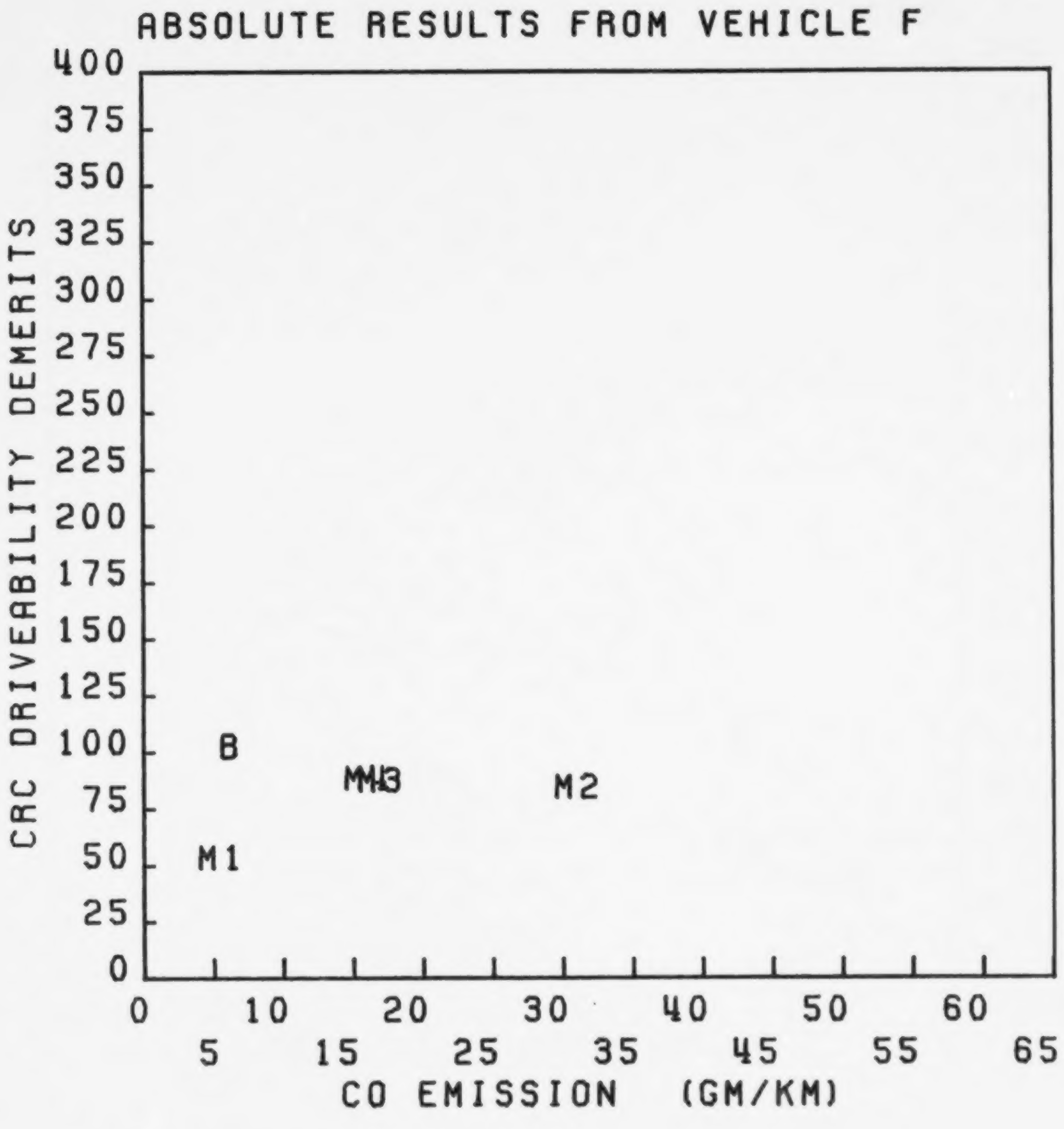
ABSOLUTE RESULTS FROM VEHICLE E

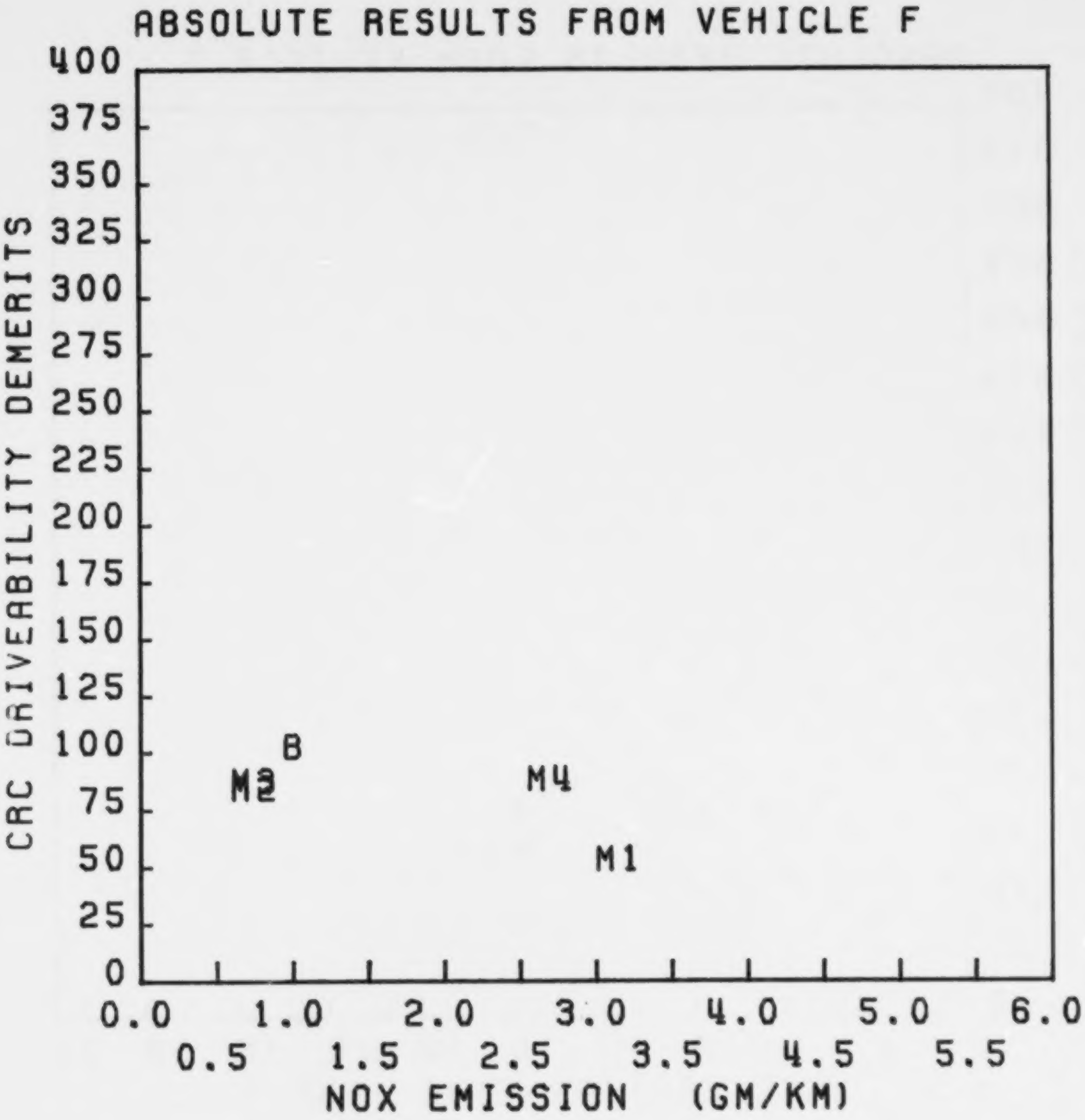
ABSOLUTE RESULTS FROM VEHICLE F
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
ACCELERATION TIME (SECS.)
0
2
4
6
8
10
12
14
16
18
20
B
M3
M2
M1

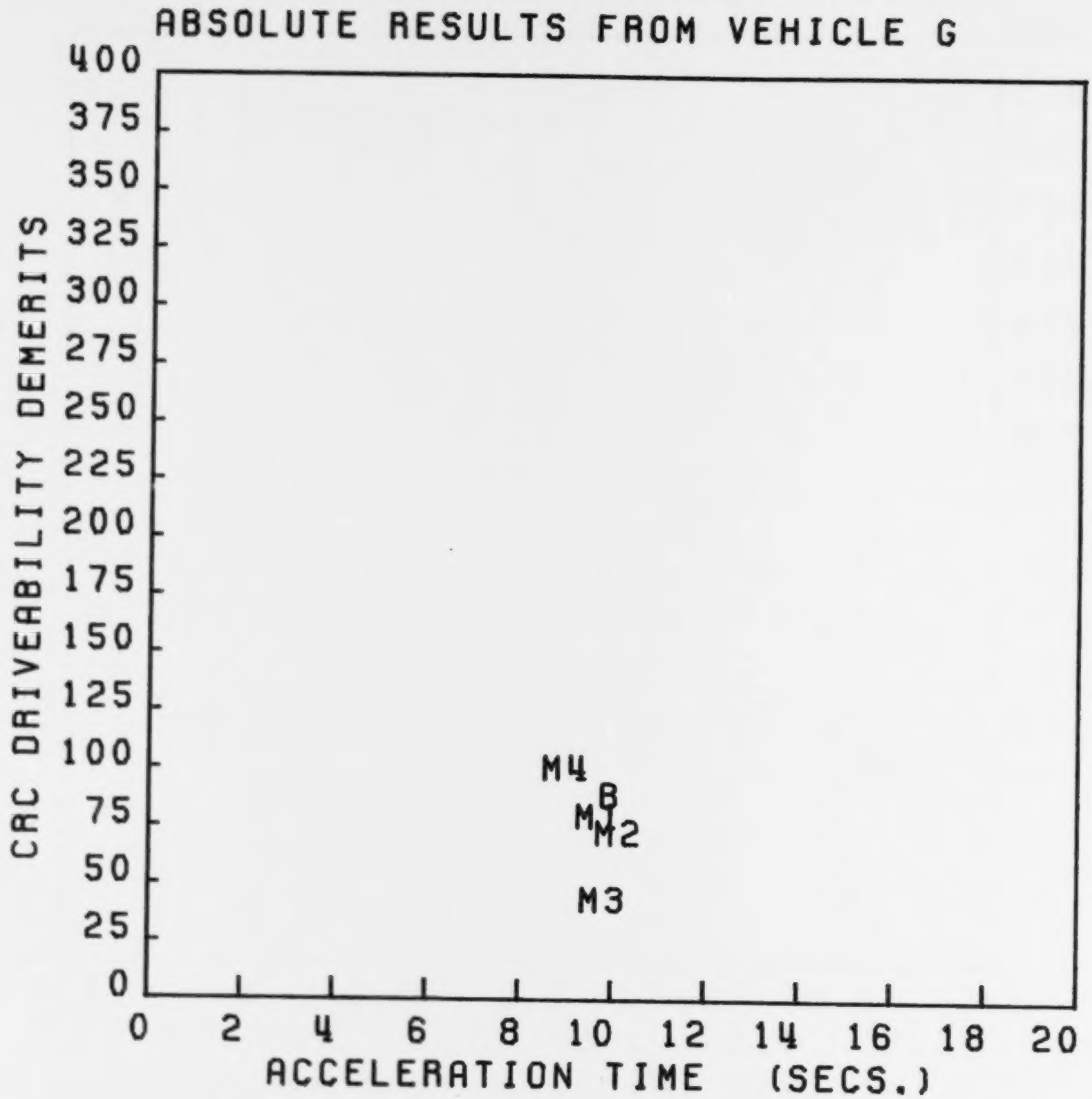

ABSOLUTE RESULTS FROM VEHICLE F
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
B
M
M3
M2
M1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)

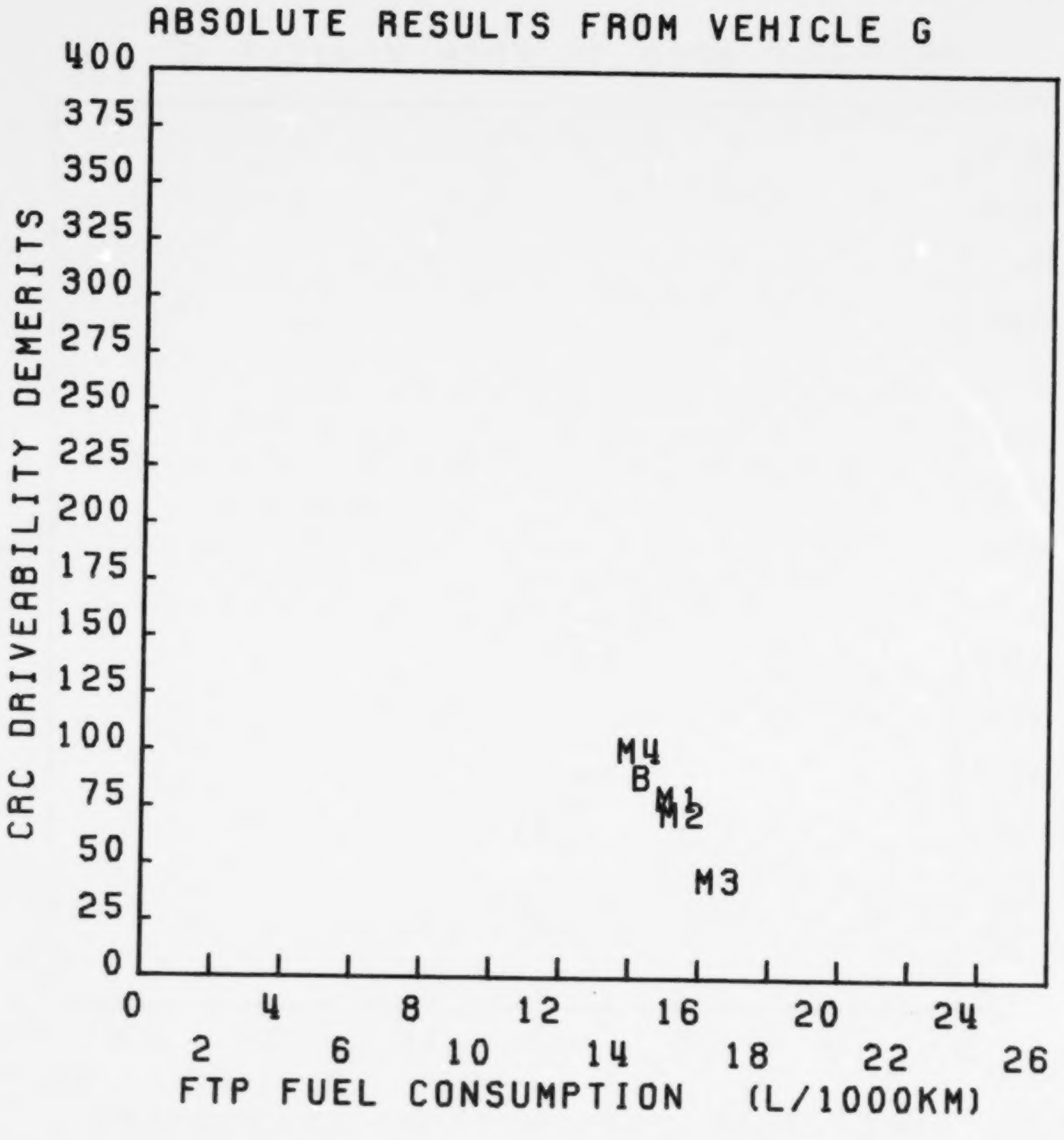

ABSOLUTE RESULTS FROM VEHICLE F
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M2
M1
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)


ABSOLUTE RESULTS FROM VEHICLE F
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M1
M3
M4
M2
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)

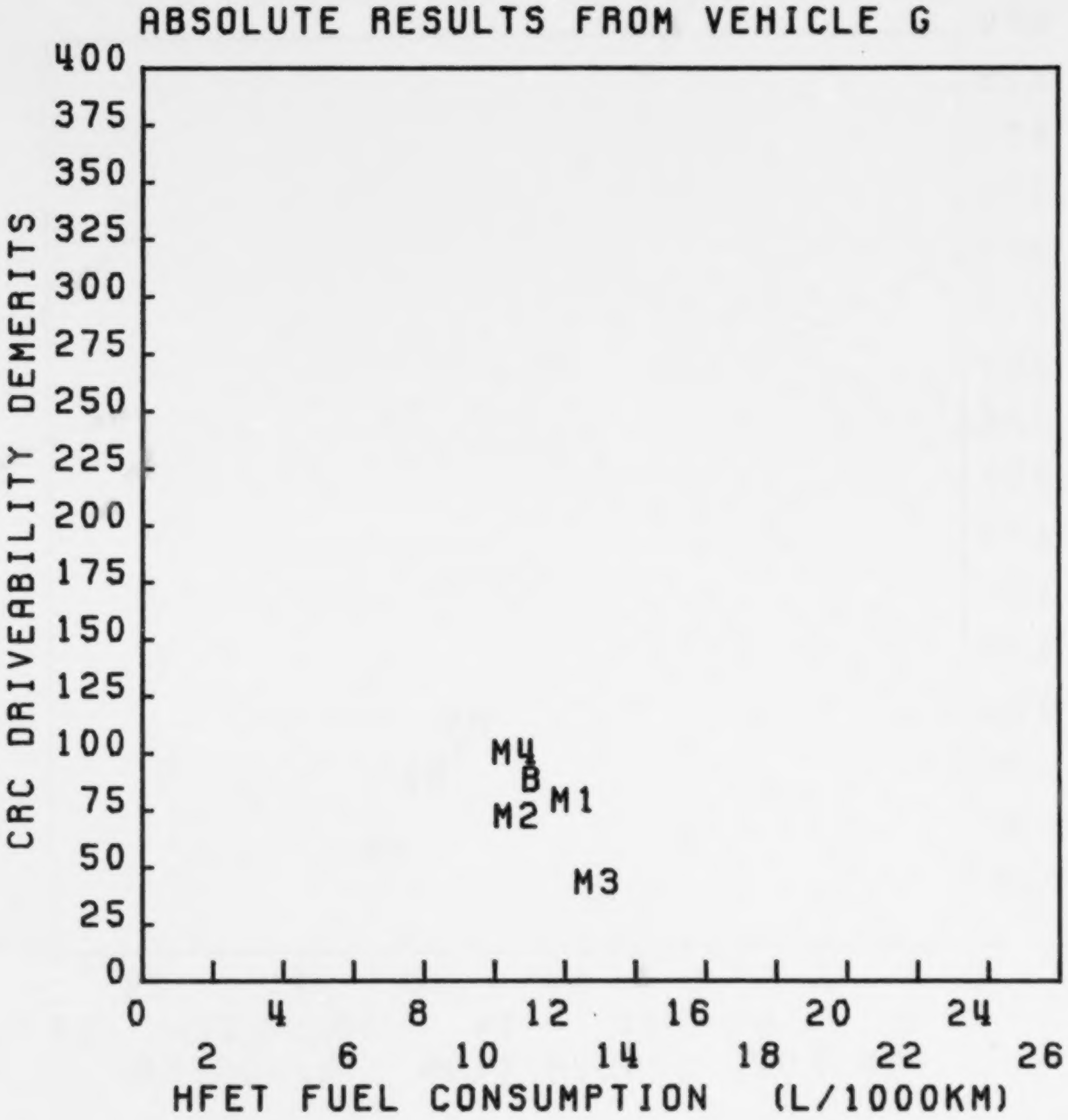

ABSOLUTE RESULTS FROM VEHICLE F
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
MM3
M2
M1
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

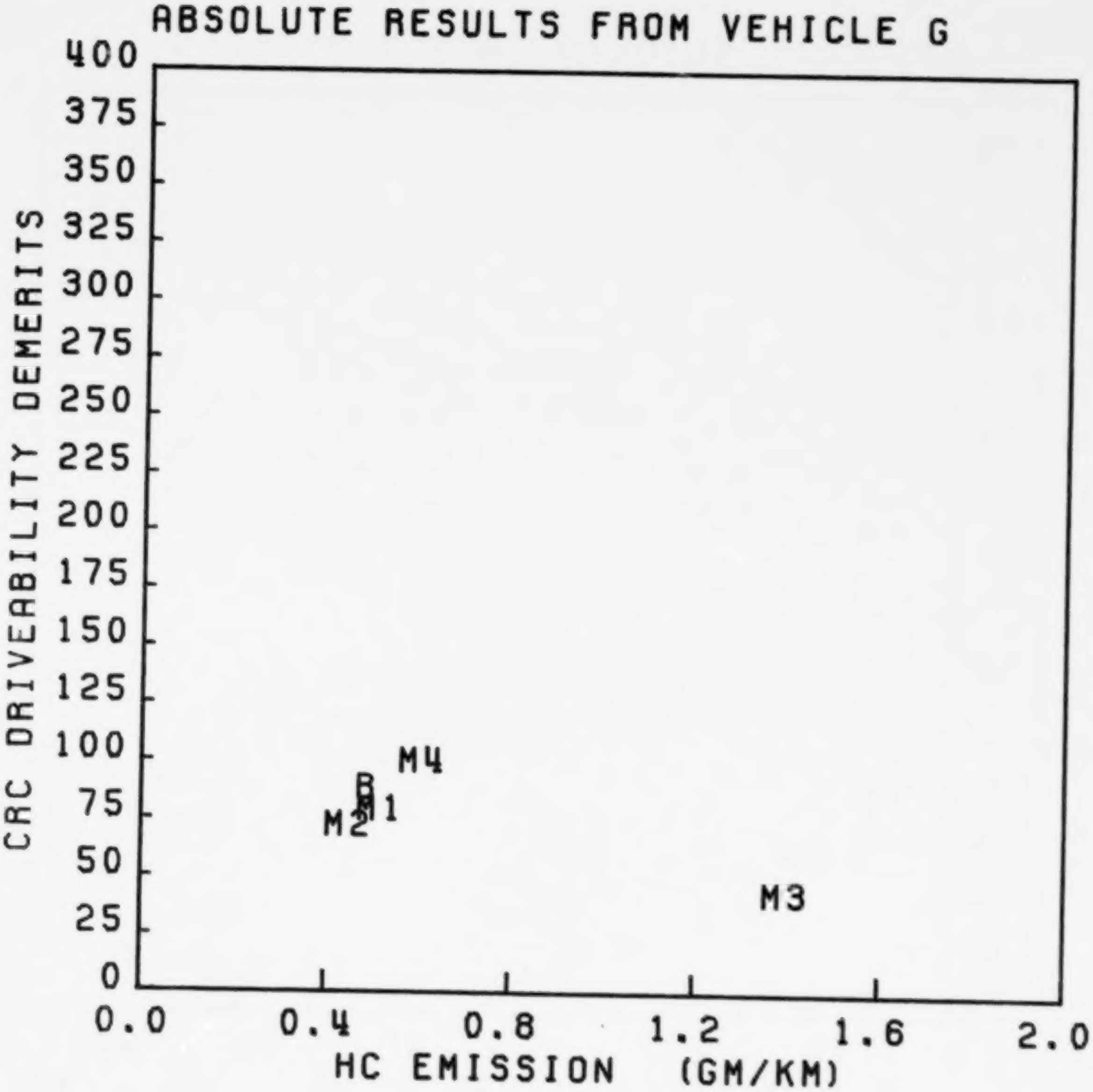

ABSOLUTE RESULTS FROM VEHICLE F
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)

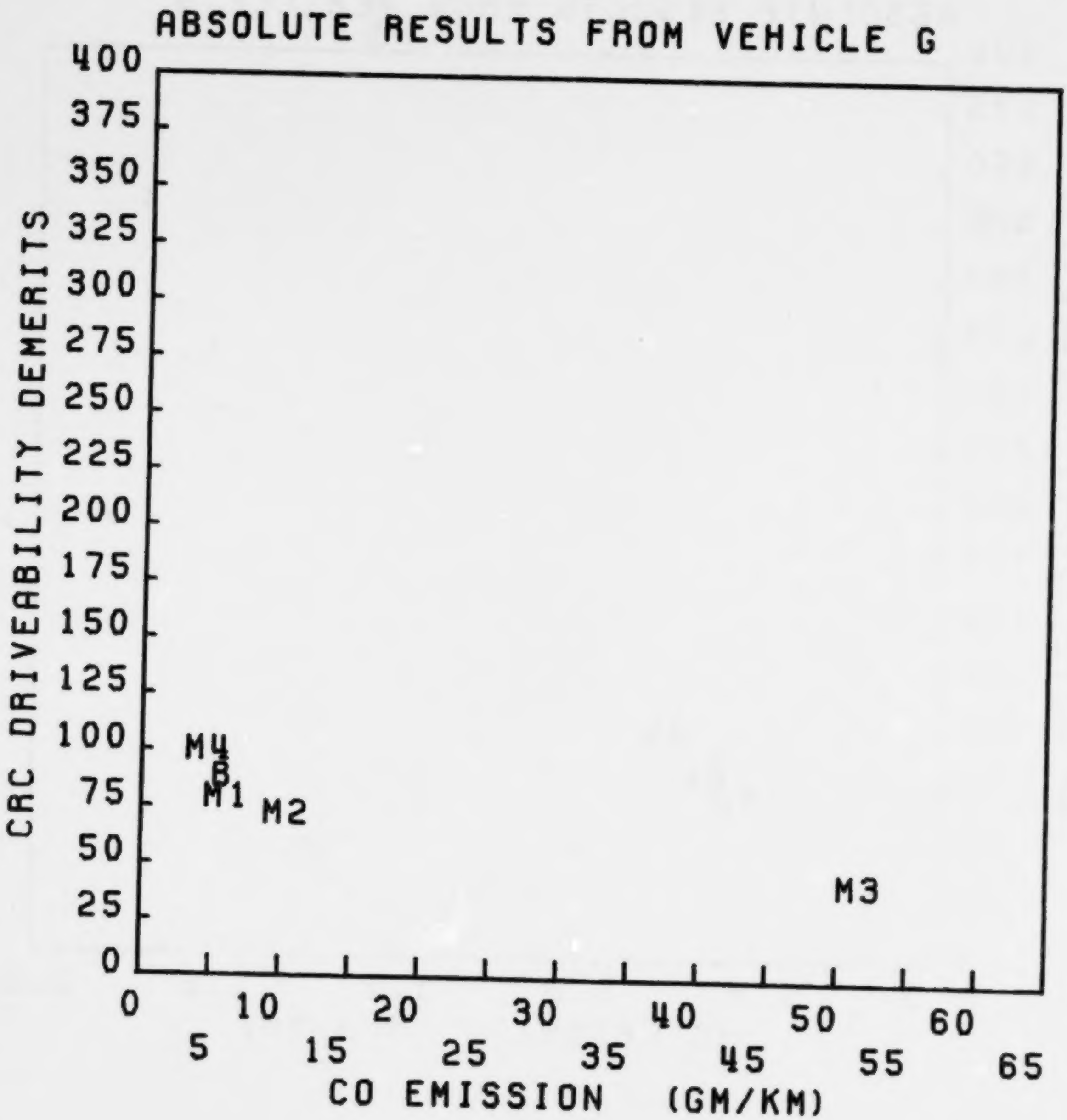

ABSOLUTE RESULTS FROM VEHICLE G
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)
M4
B
M1
M2
M3

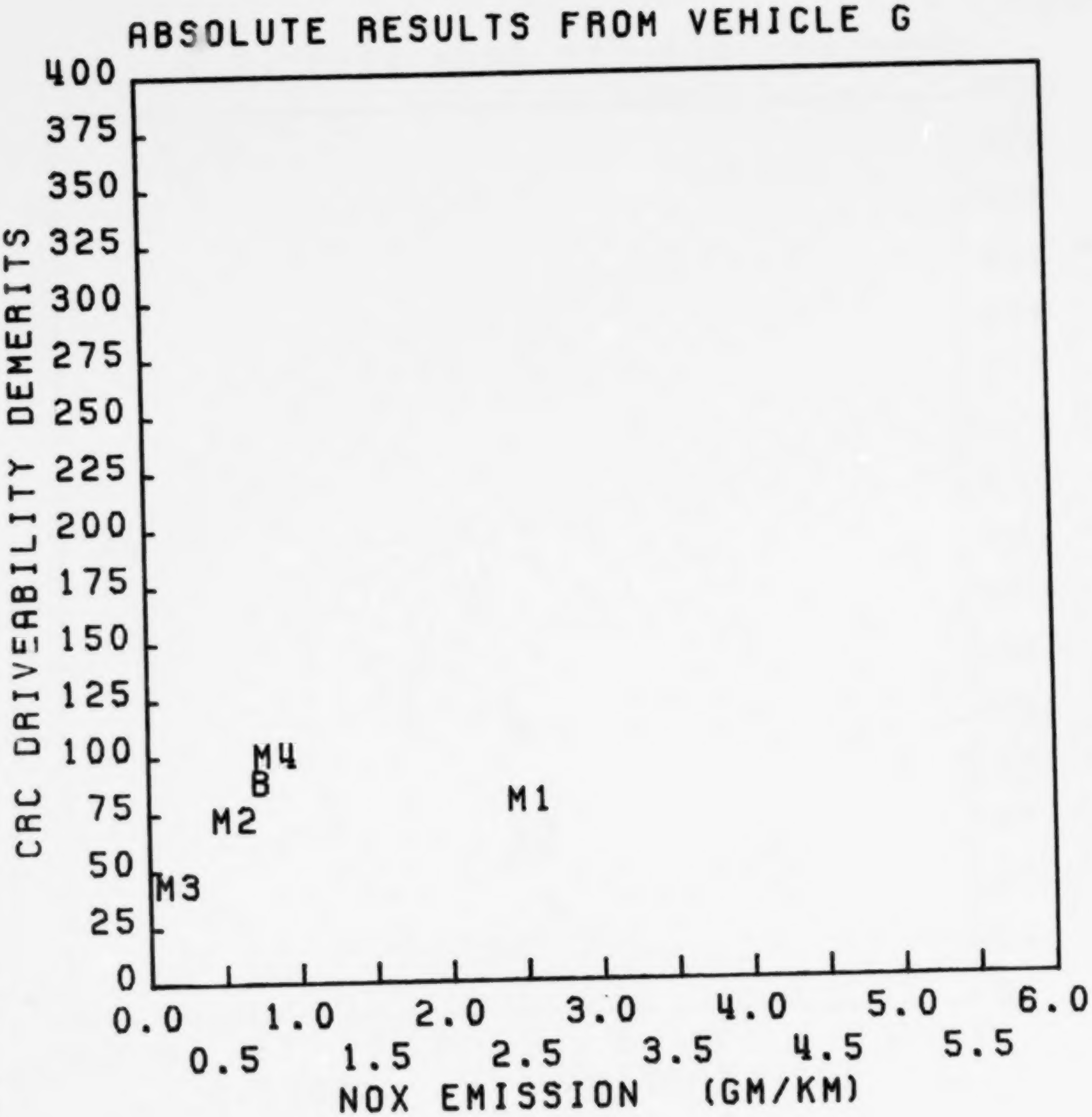


ABSOLUTE RESULTS FROM VEHICLE G
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M1
M2
M3
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)

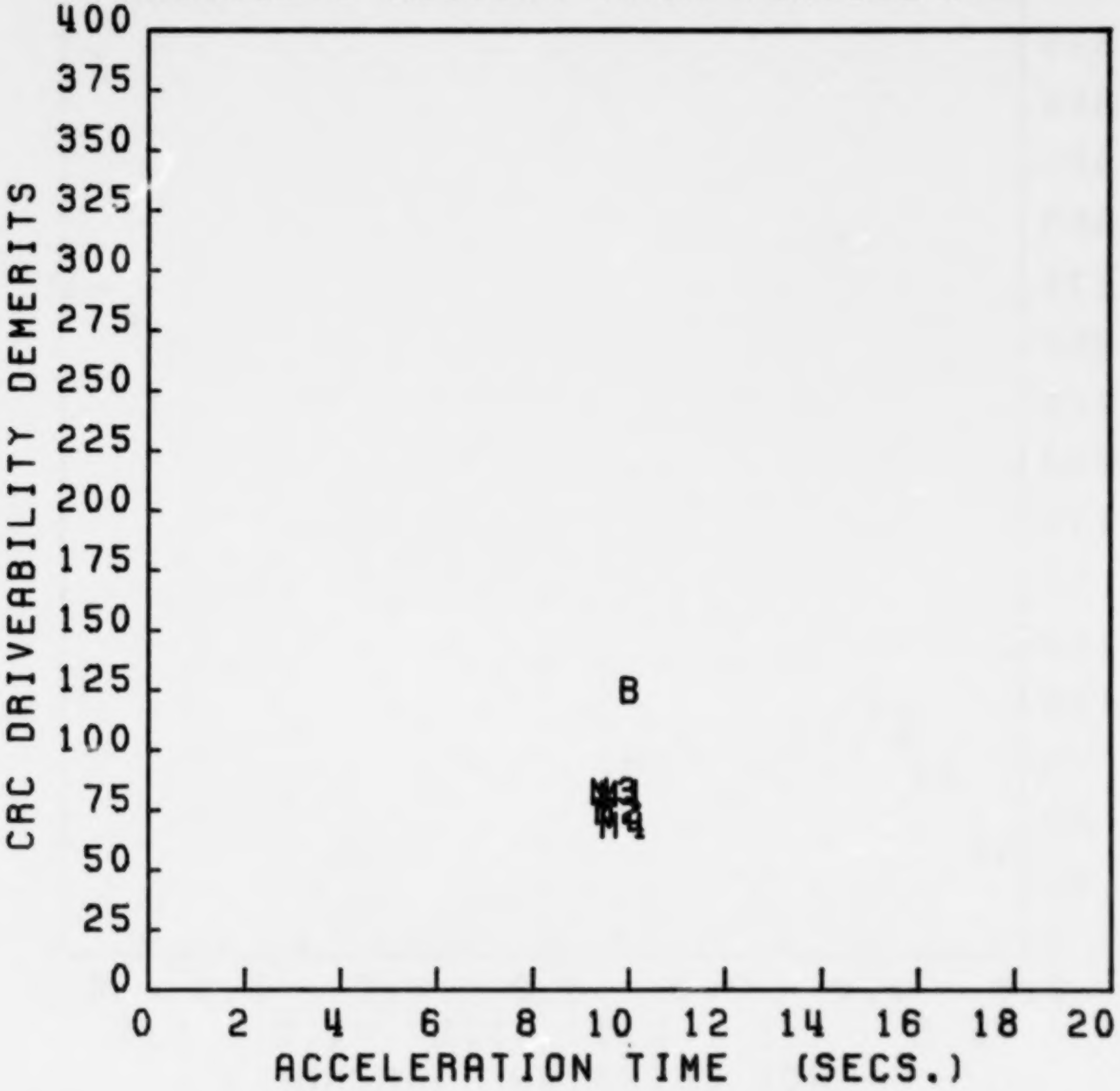

ABSOLUTE RESULTS FROM VEHICLE G
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M1
M2
M3
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)


ABSOLUTE RESULTS FROM VEHICLE G
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M4
B
M1
M2
M3

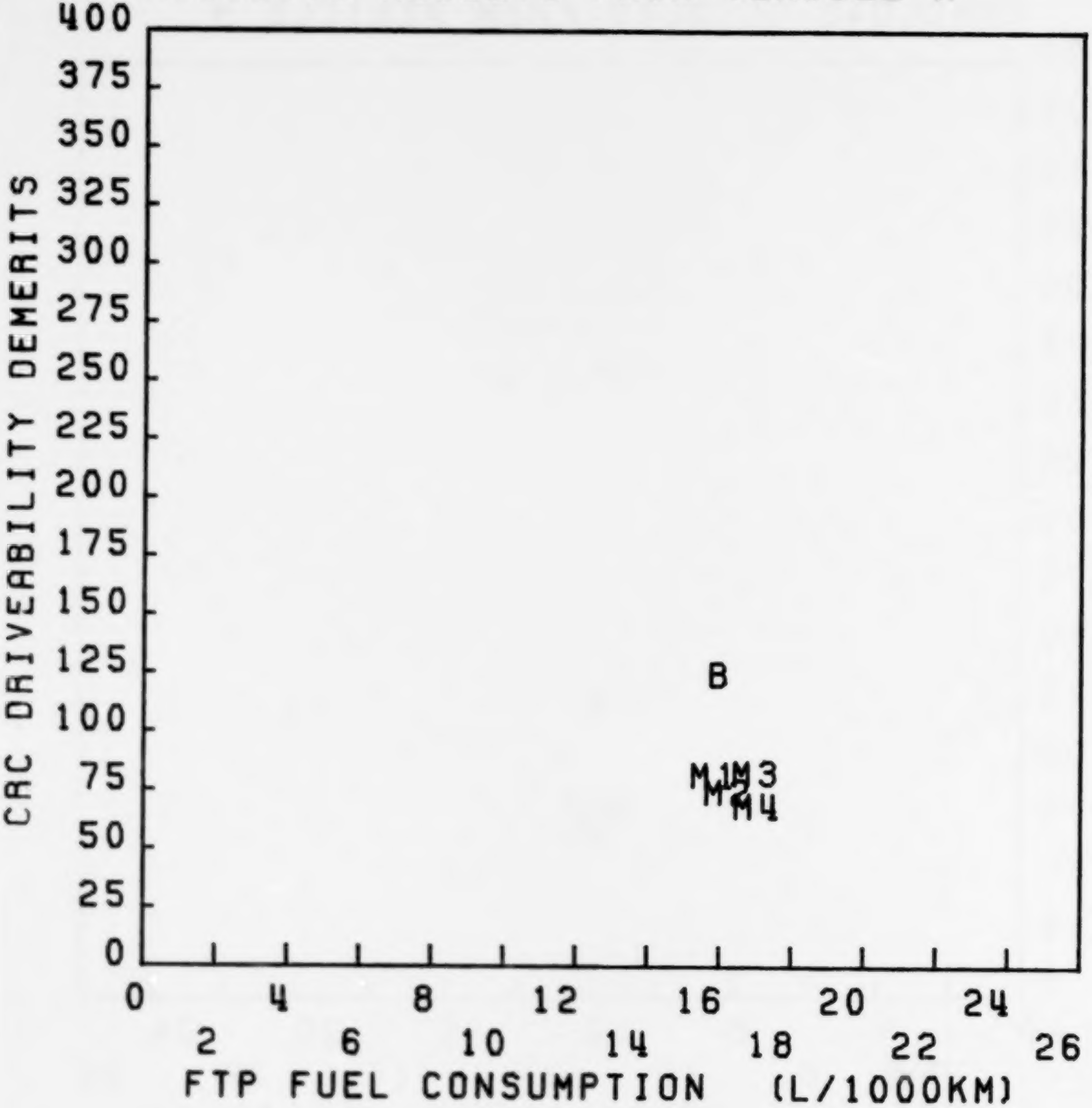

ABSOLUTE RESULTS FROM VEHICLE G
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M1
M2
M3
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

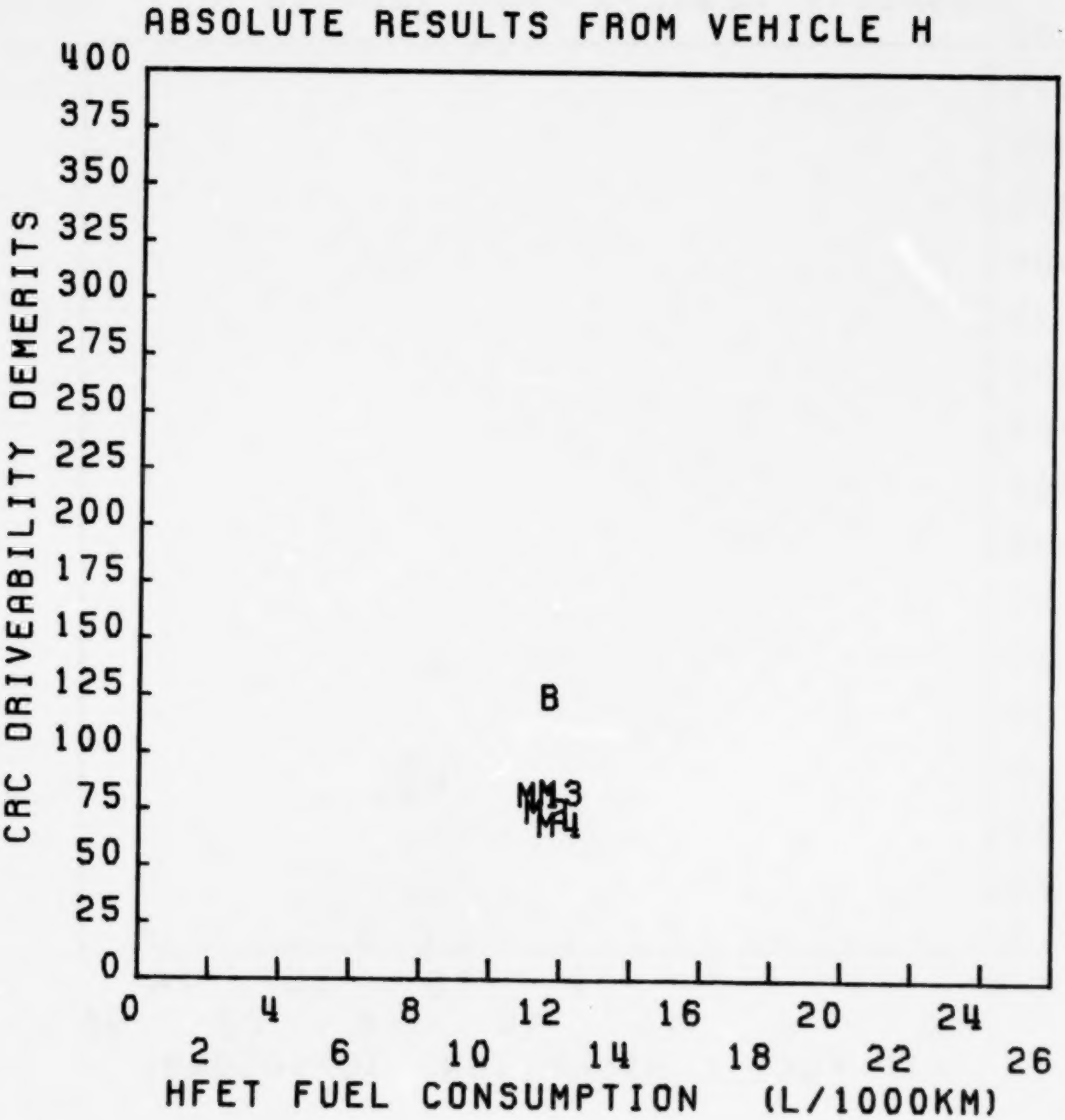

ABSOLUTE RESULTS FROM VEHICLE G
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M1
M2
M3
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

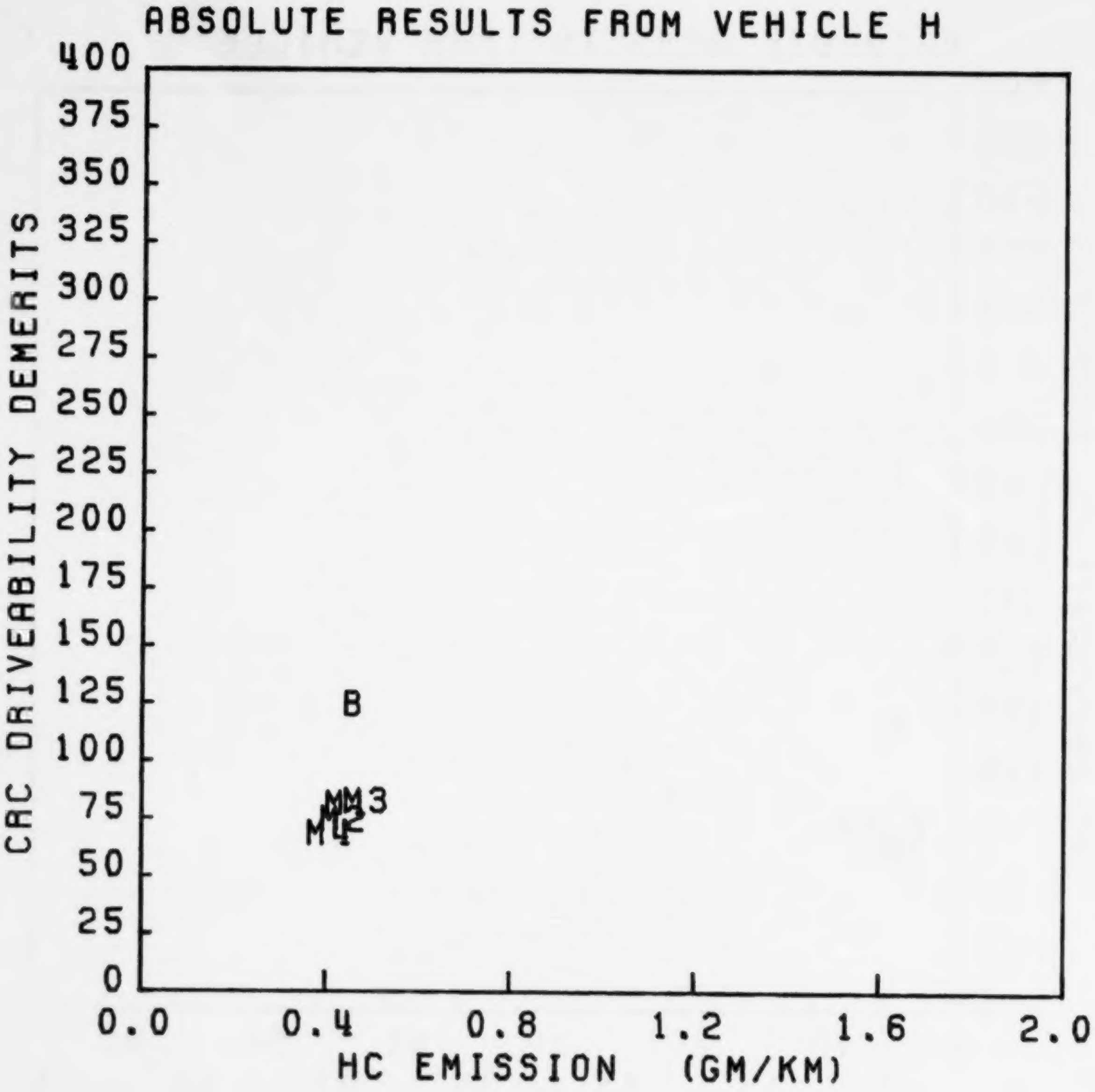
ABSOLUTE RESULTS FROM VEHICLE H

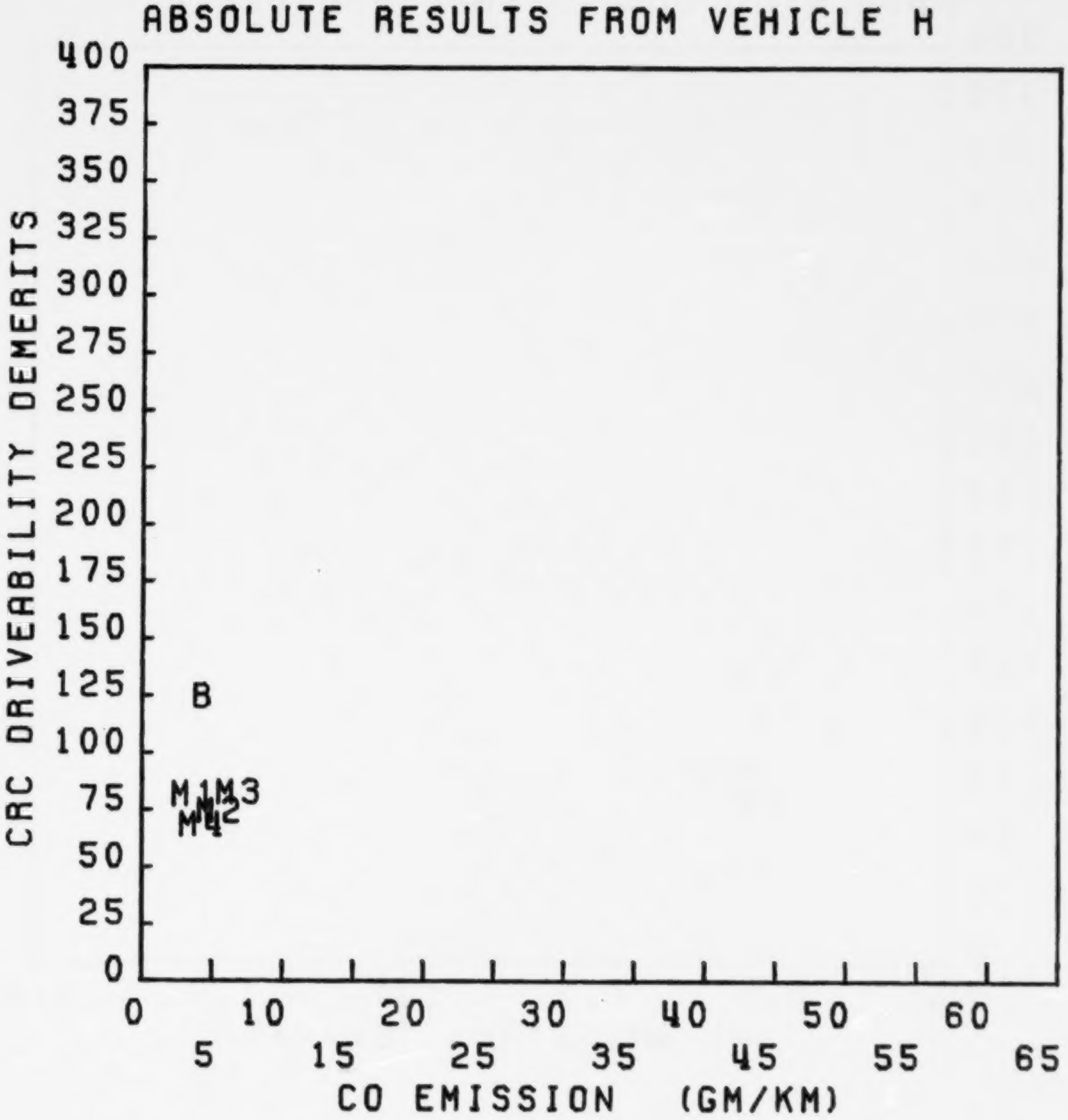


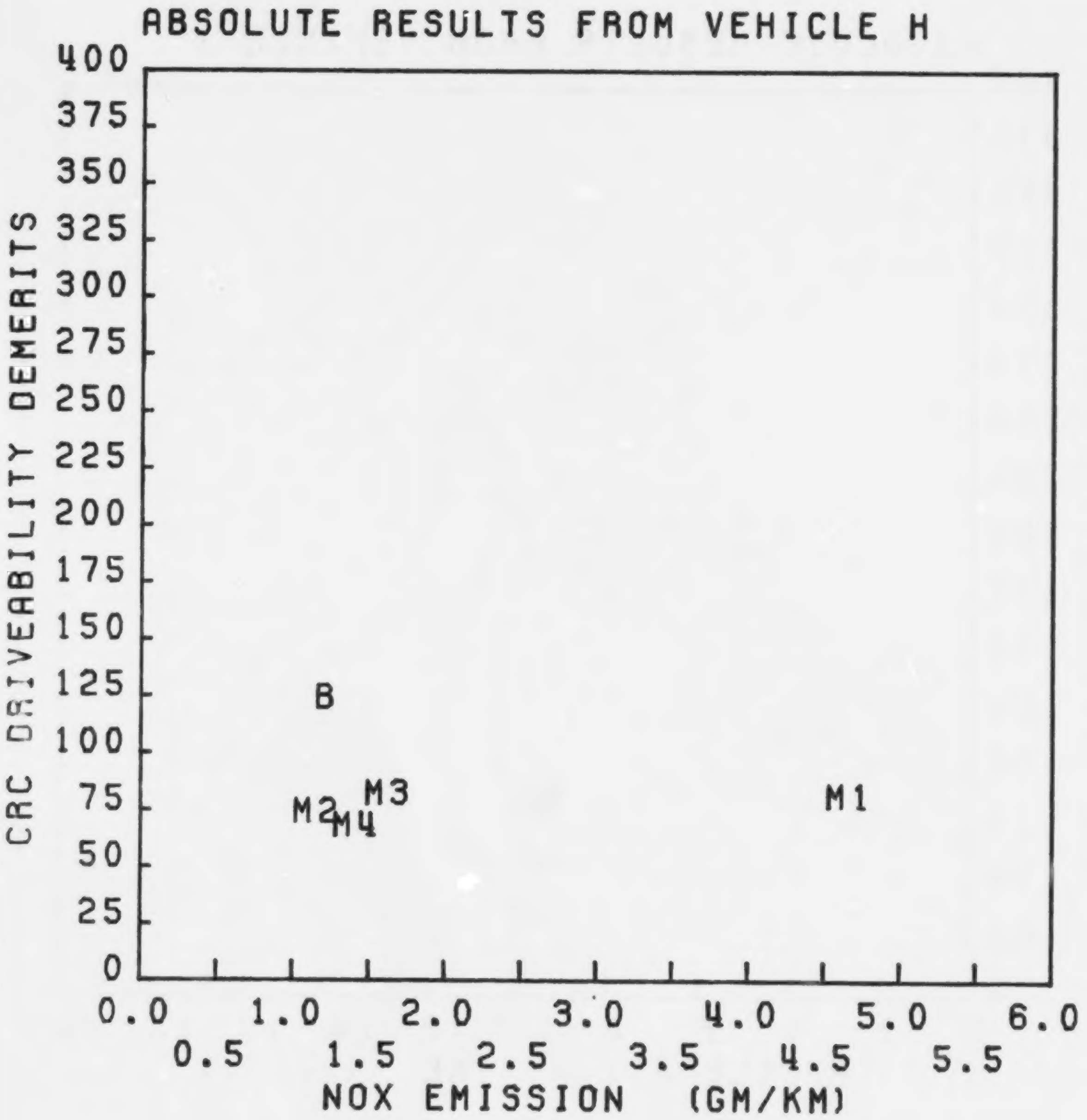
ABSOLUTE RESULTS FROM VEHICLE H

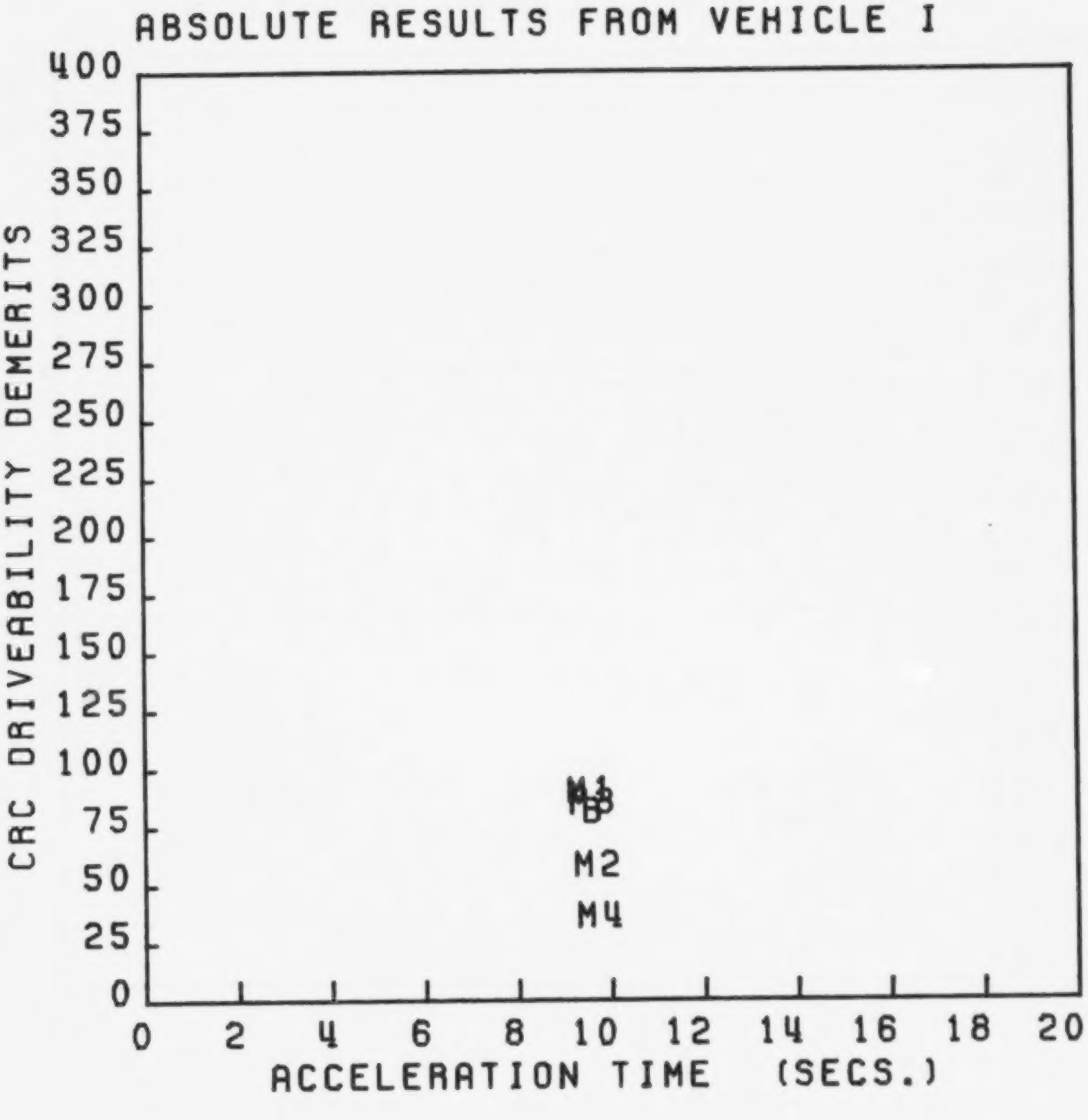


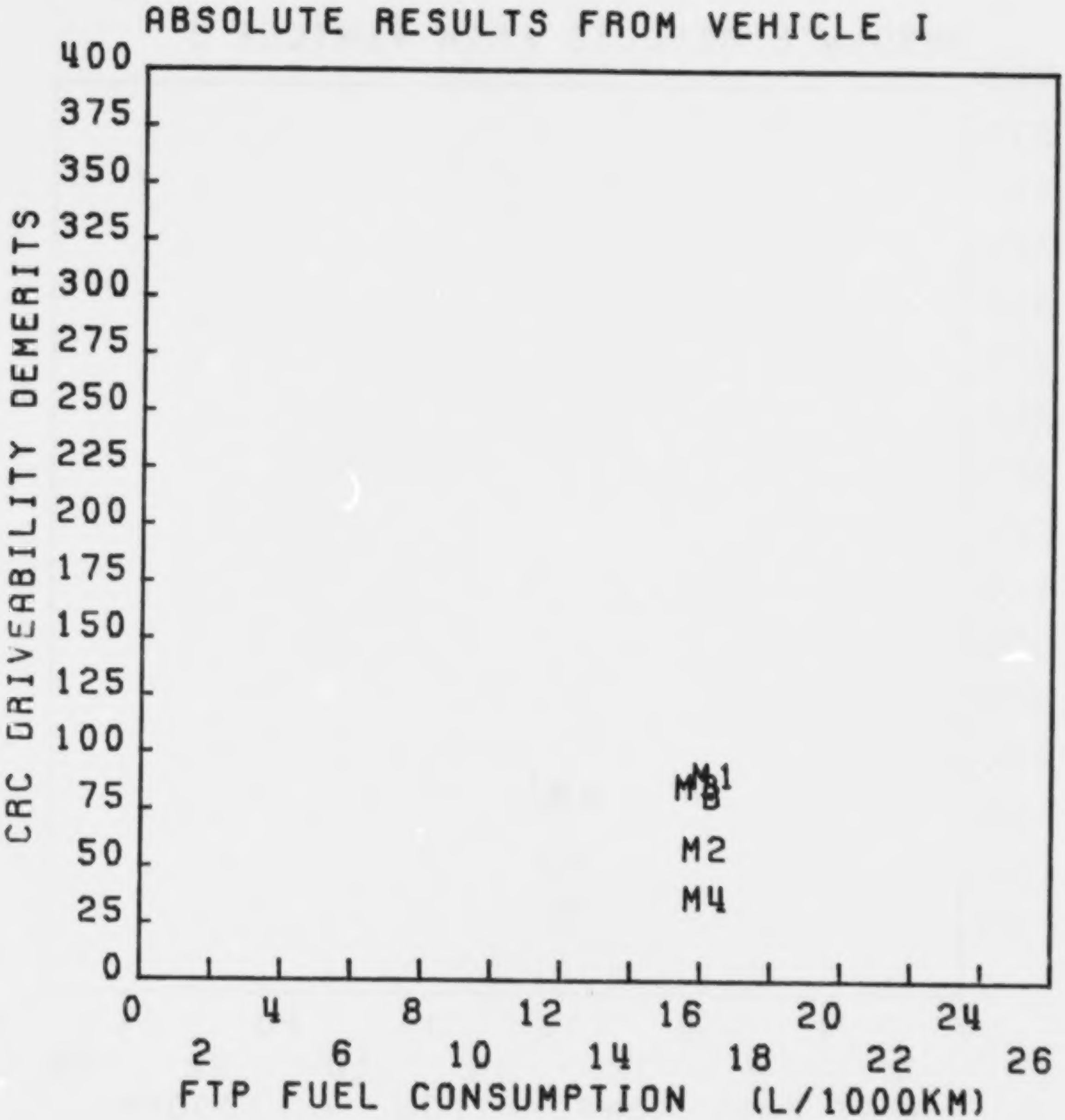

ABSOLUTE RESULTS FROM VEHICLE H
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
MM3
M2
M4
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

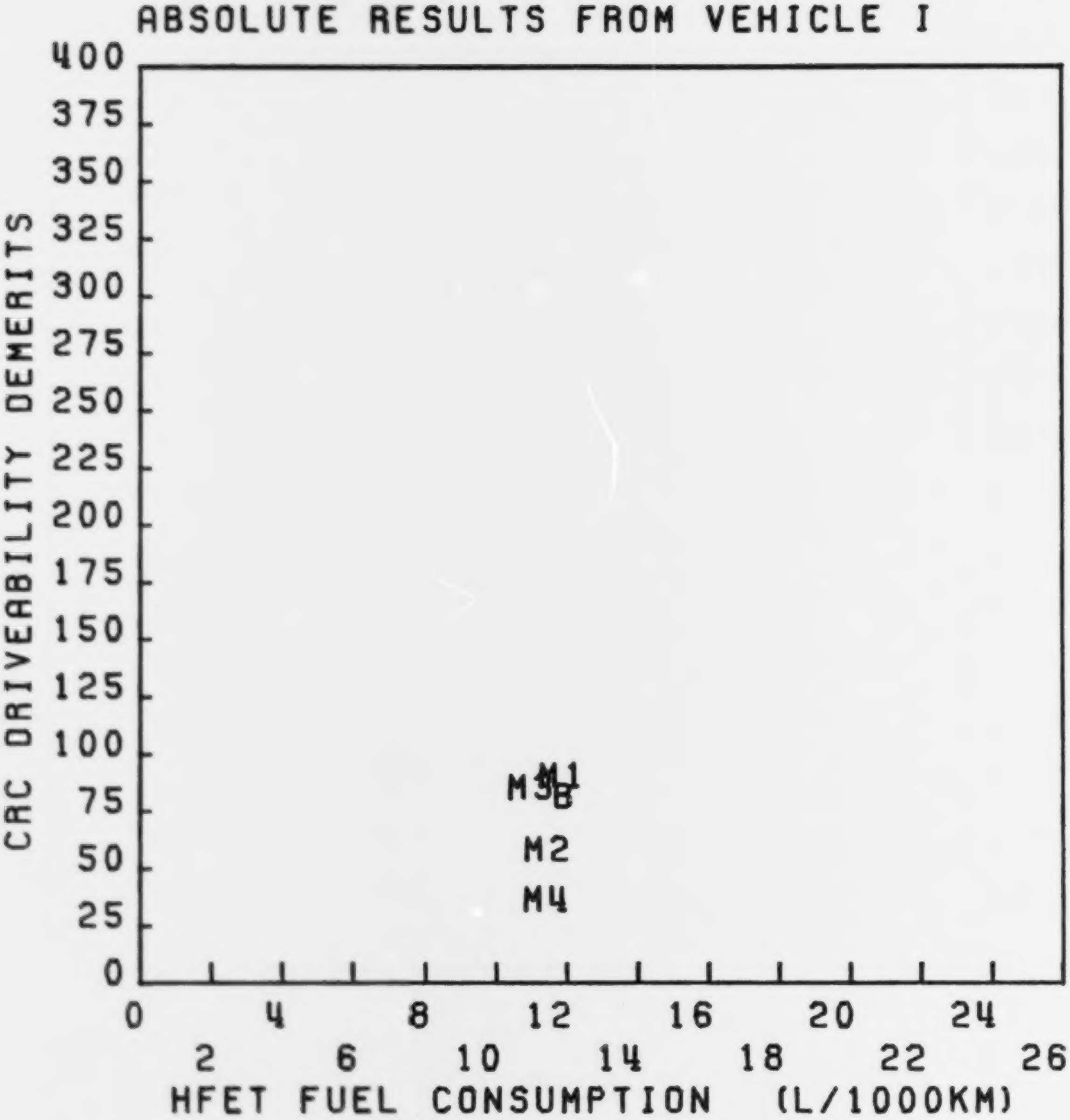

ABSOLUTE RESULTS FROM VEHICLE H
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
B
MM3
M2
M4F


ABSOLUTE RESULTS FROM VEHICLE H
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M1
M3
M2
M4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

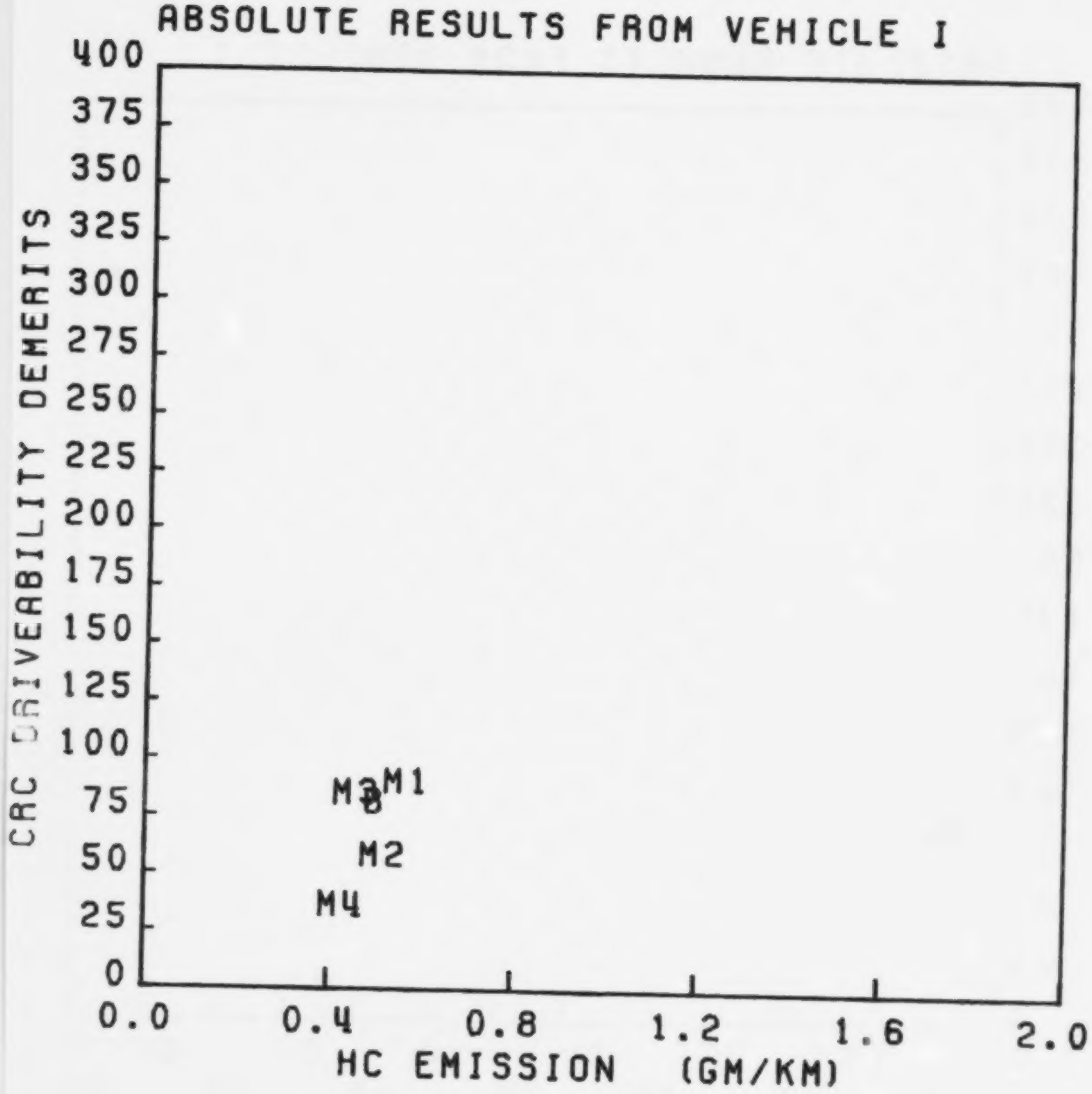

ABSOLUTE RESULTS FROM VEHICLE H
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M2
M4
M3
M1
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)

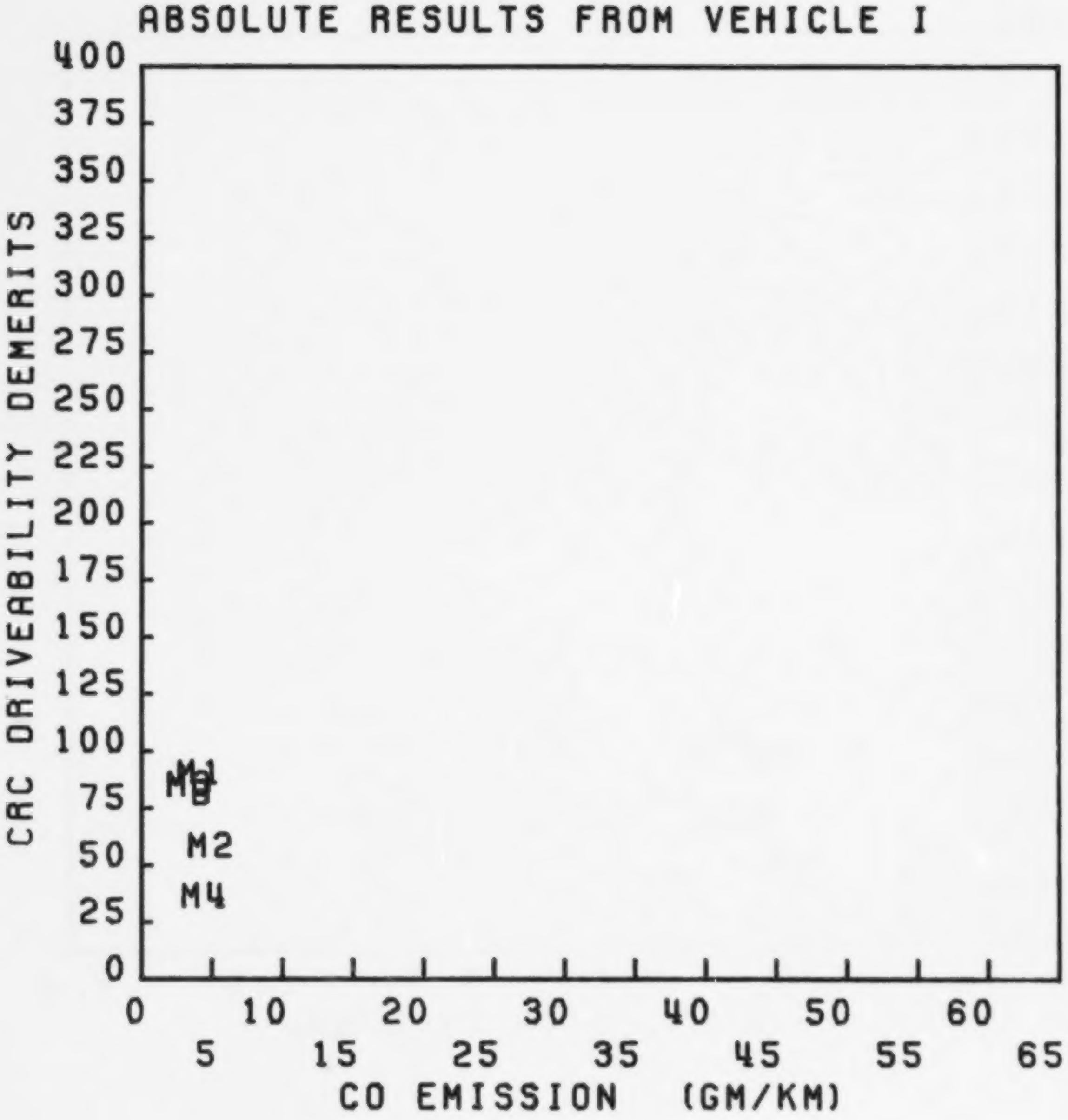

ABSOLUTE RESULTS FROM VEHICLE I
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1
M3
B
M2
M4
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)

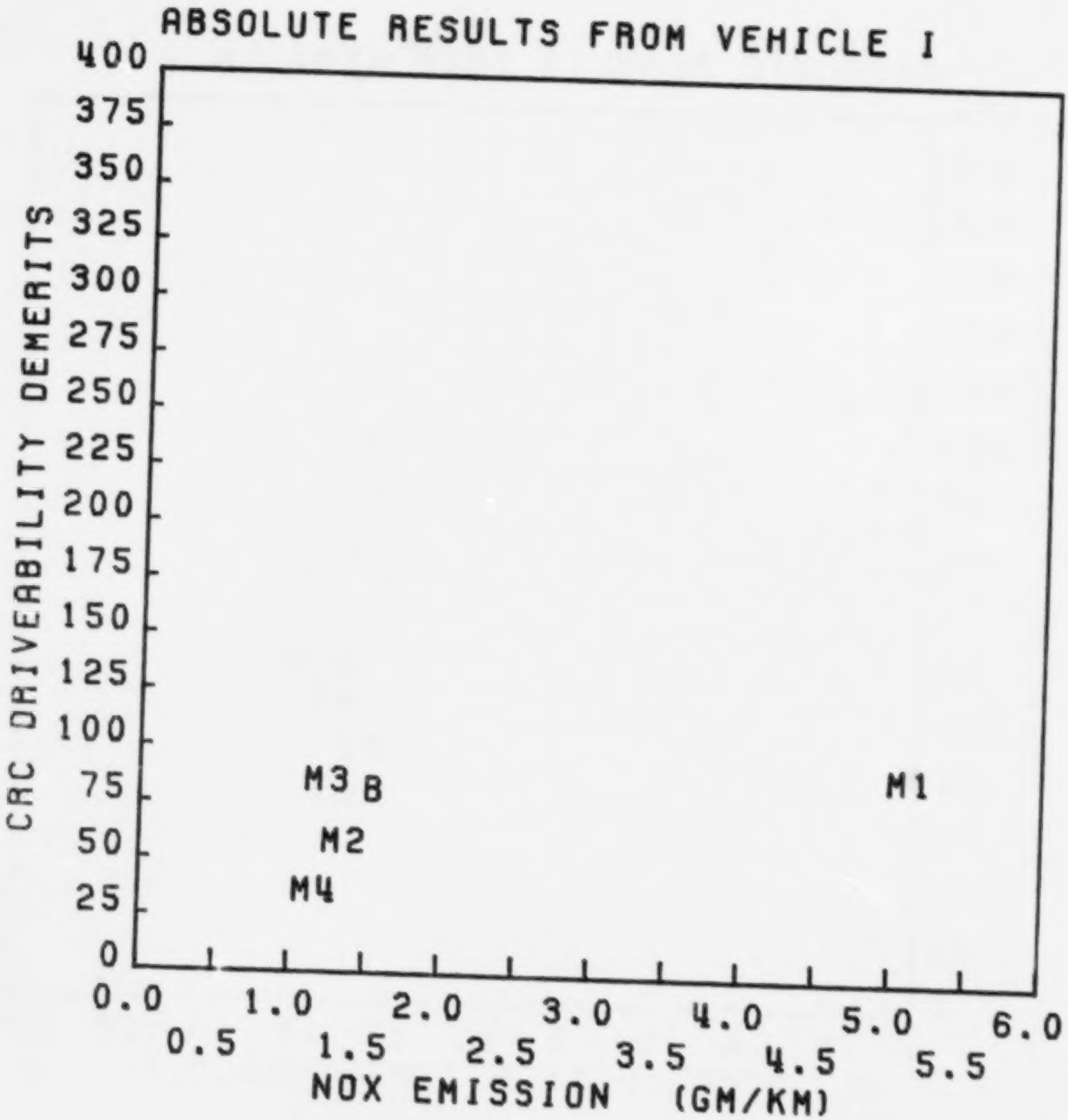

ABSOLUTE RESULTS FROM VEHICLE I
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1
MB
M2
M4
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)

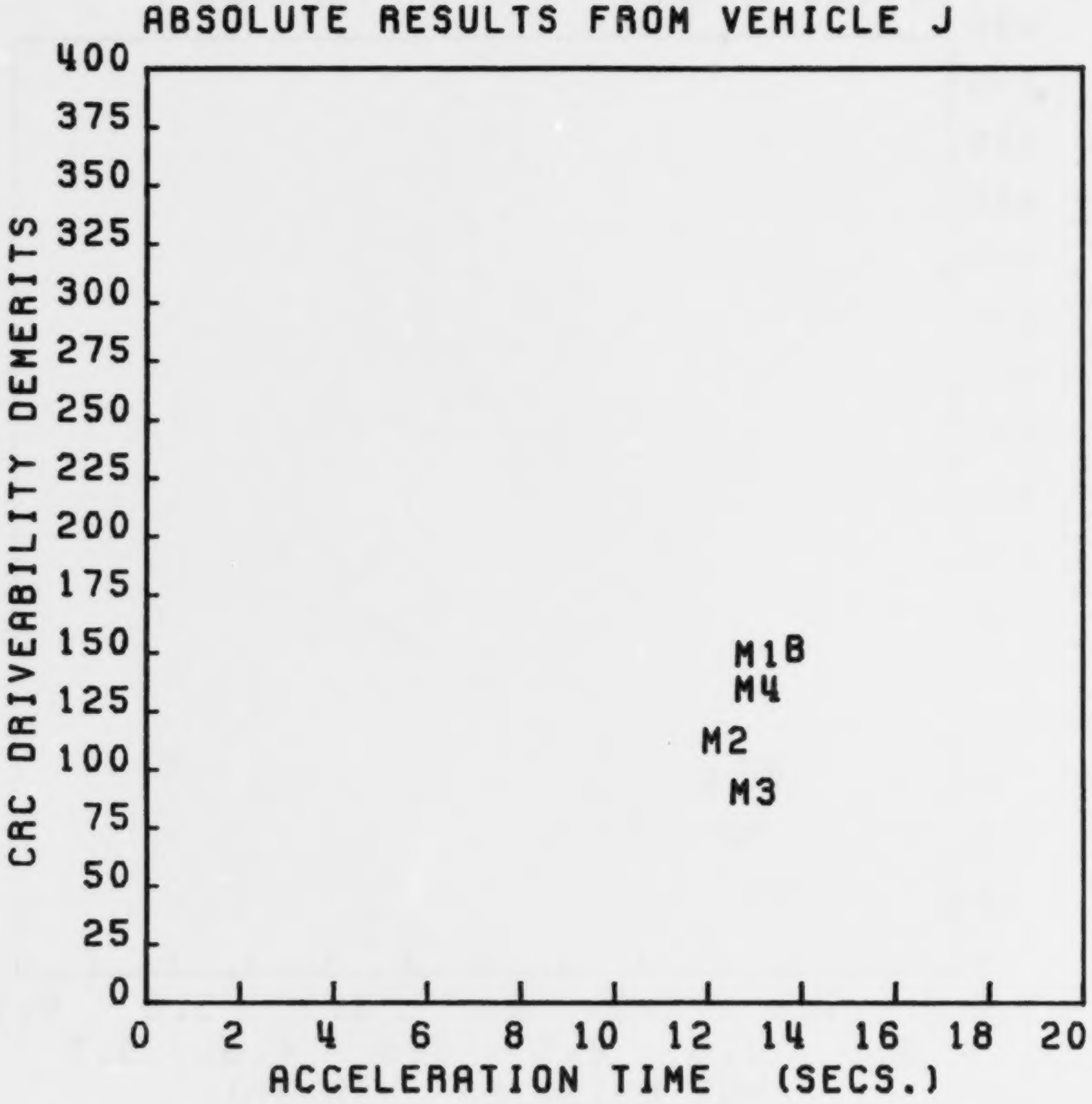


ABSOLUTE RESULTS FROM VEHICLE I
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1
M3
B
M2
M4
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

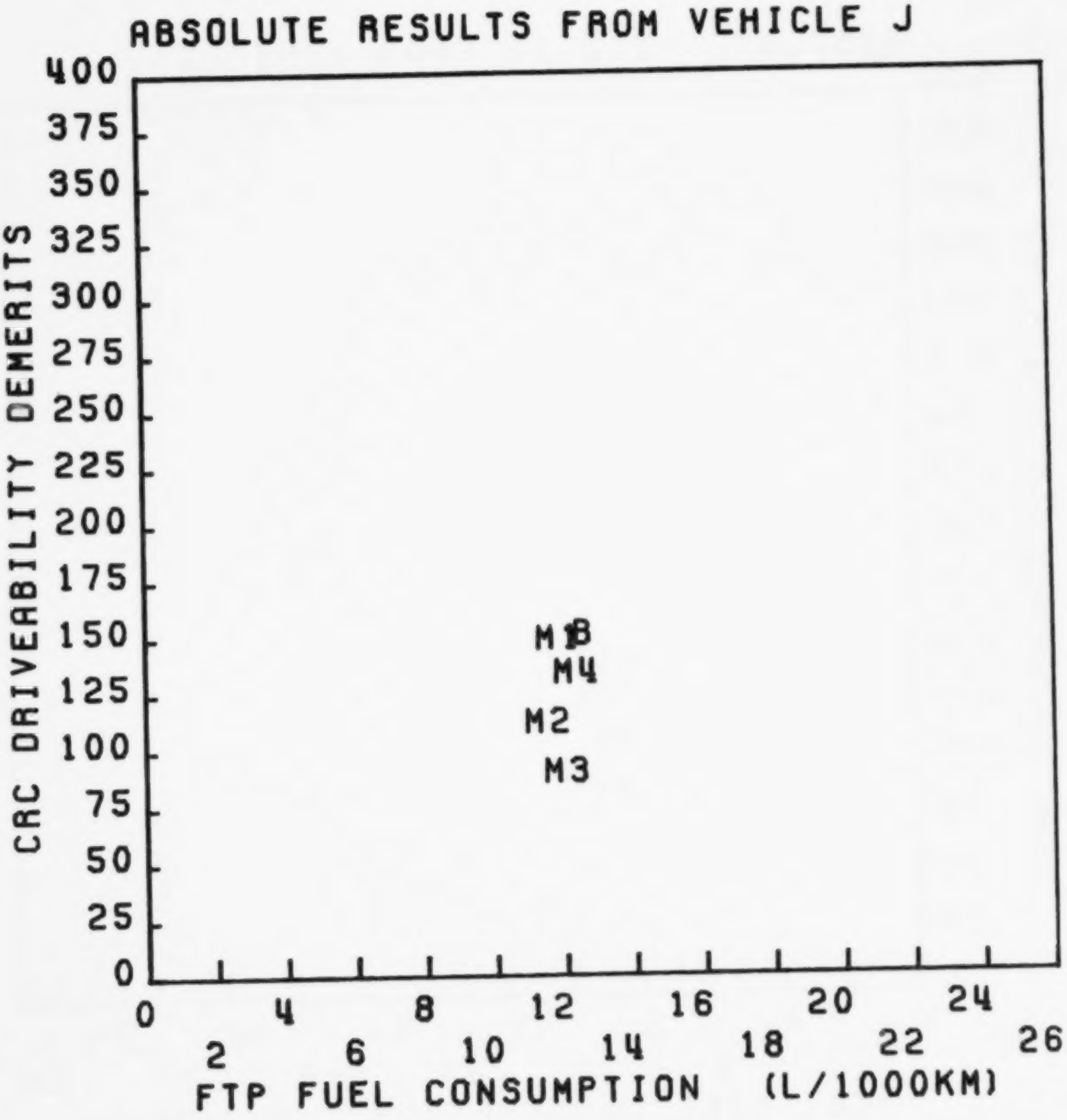

ABSOLUTE RESULTS FROM VEHICLE I
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M3
B
M1
M2
M4

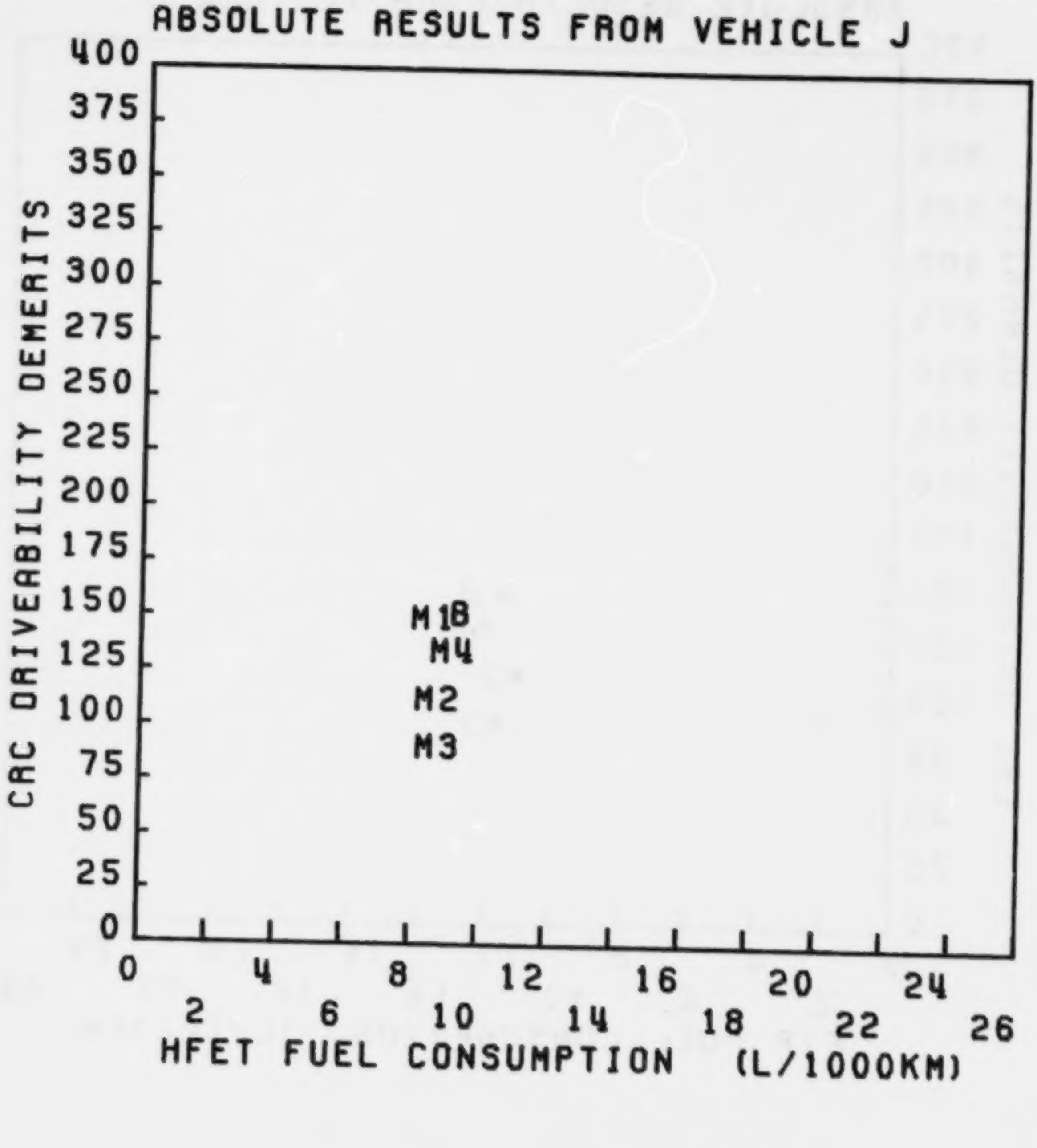

ABSOLUTE RESULTS FROM VEHICLE I
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1
M3
B
M2
M4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

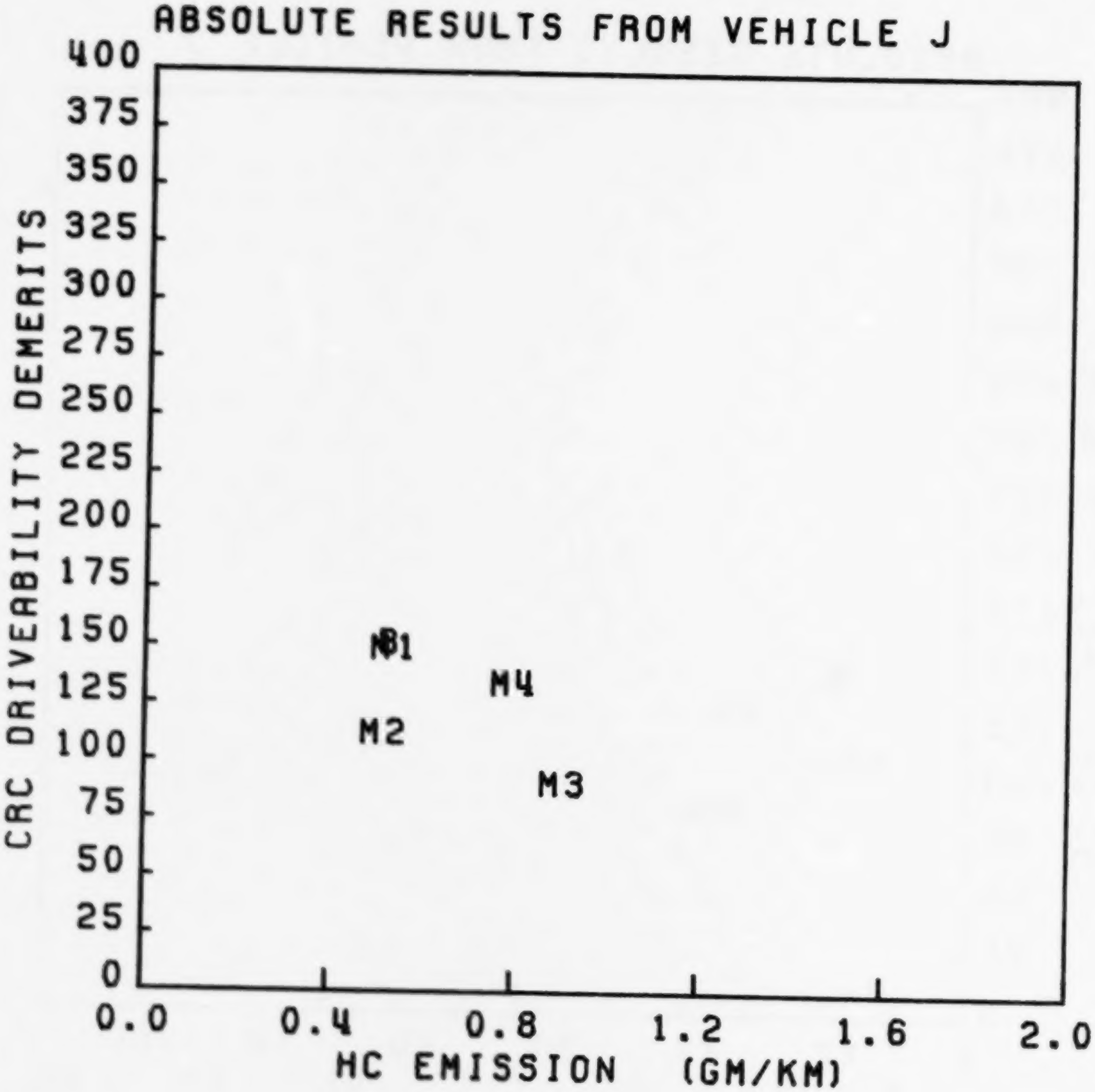

ABSOLUTE RESULTS FROM VEHICLE I
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
B
M2
M4
M1
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)



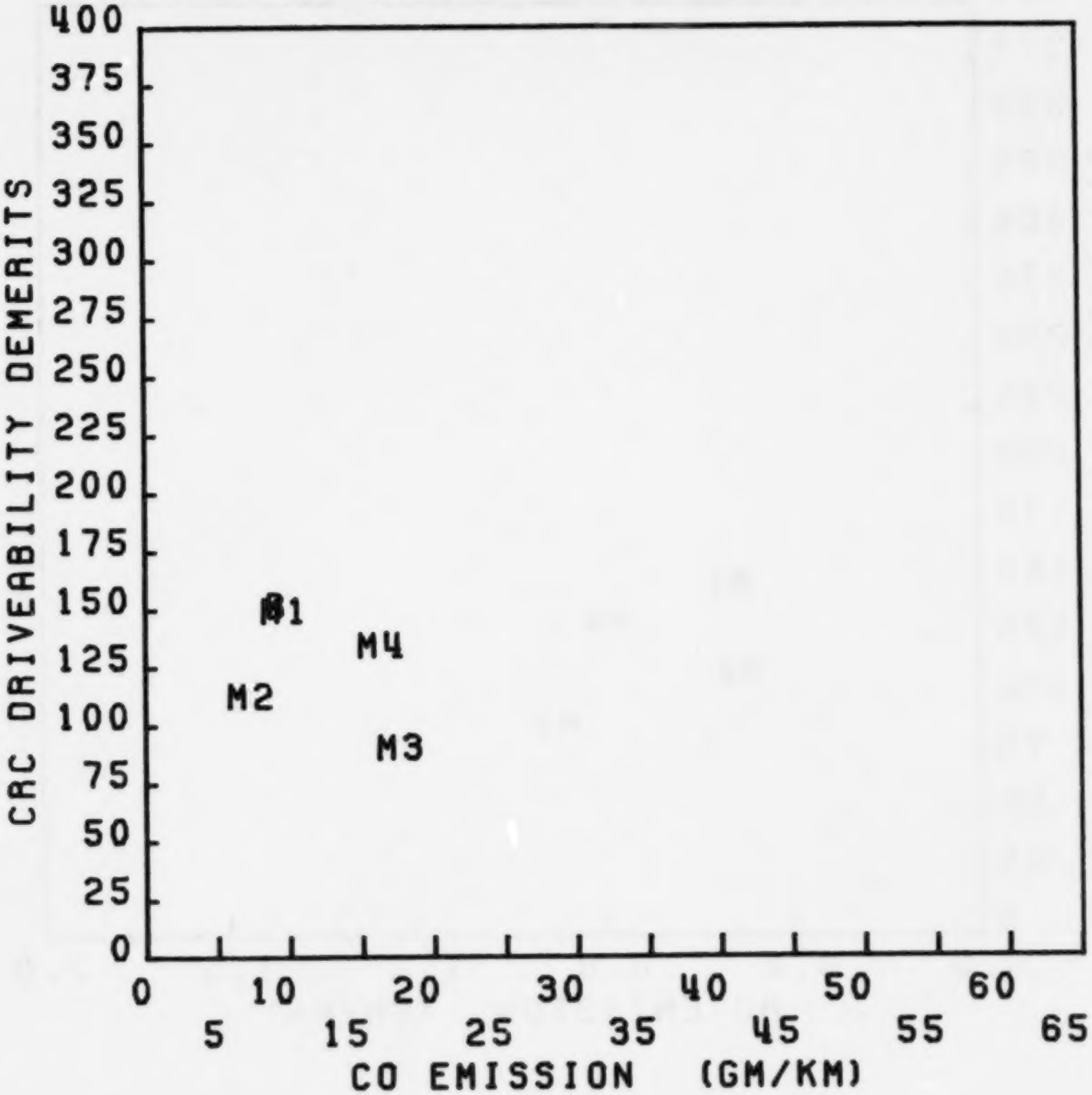
ABSOLUTE RESULTS FROM VEHICLE J

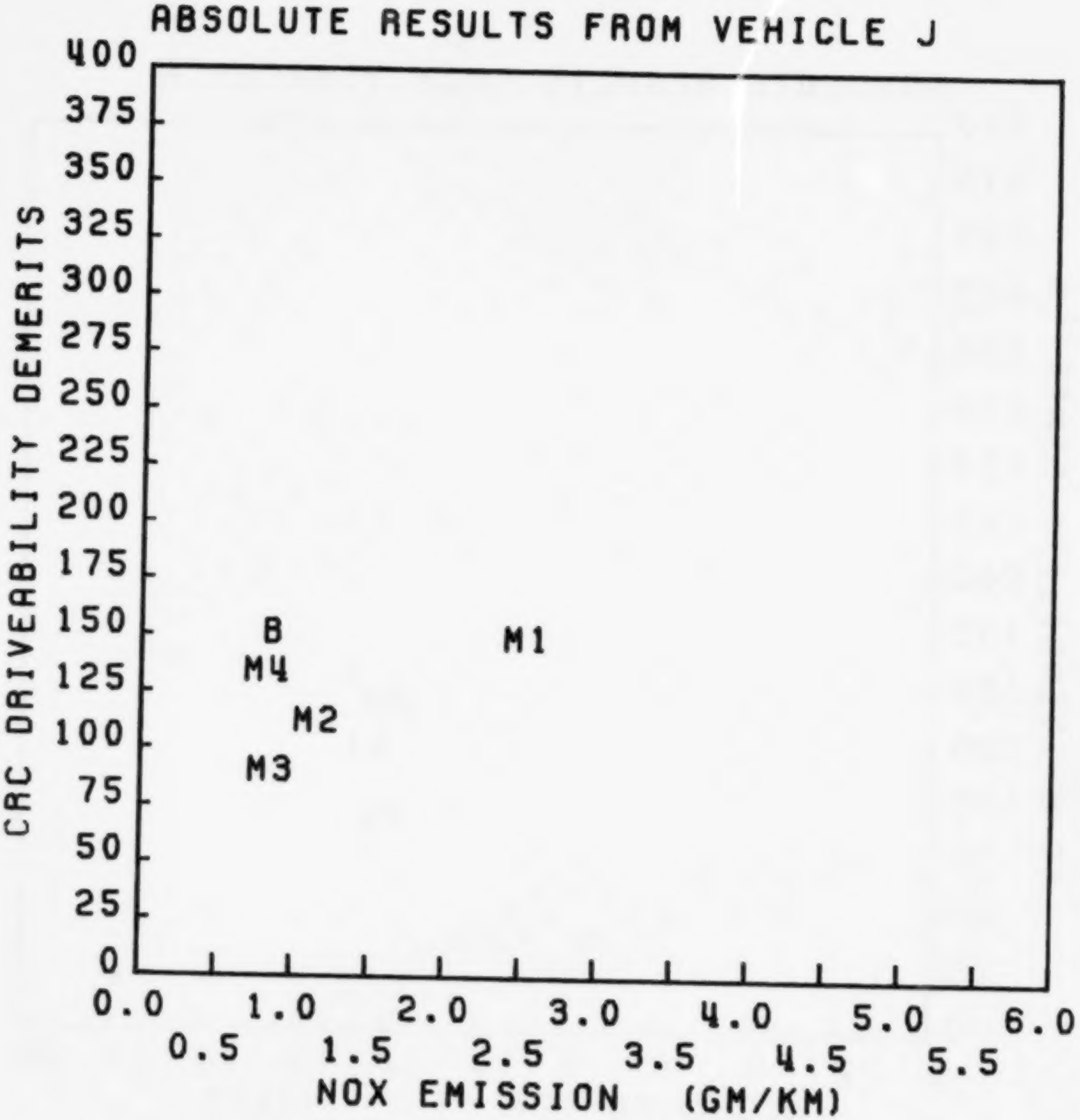

ABSOLUTE RESULTS FROM VEHICLE J
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1
B
M4
M2
M3
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)

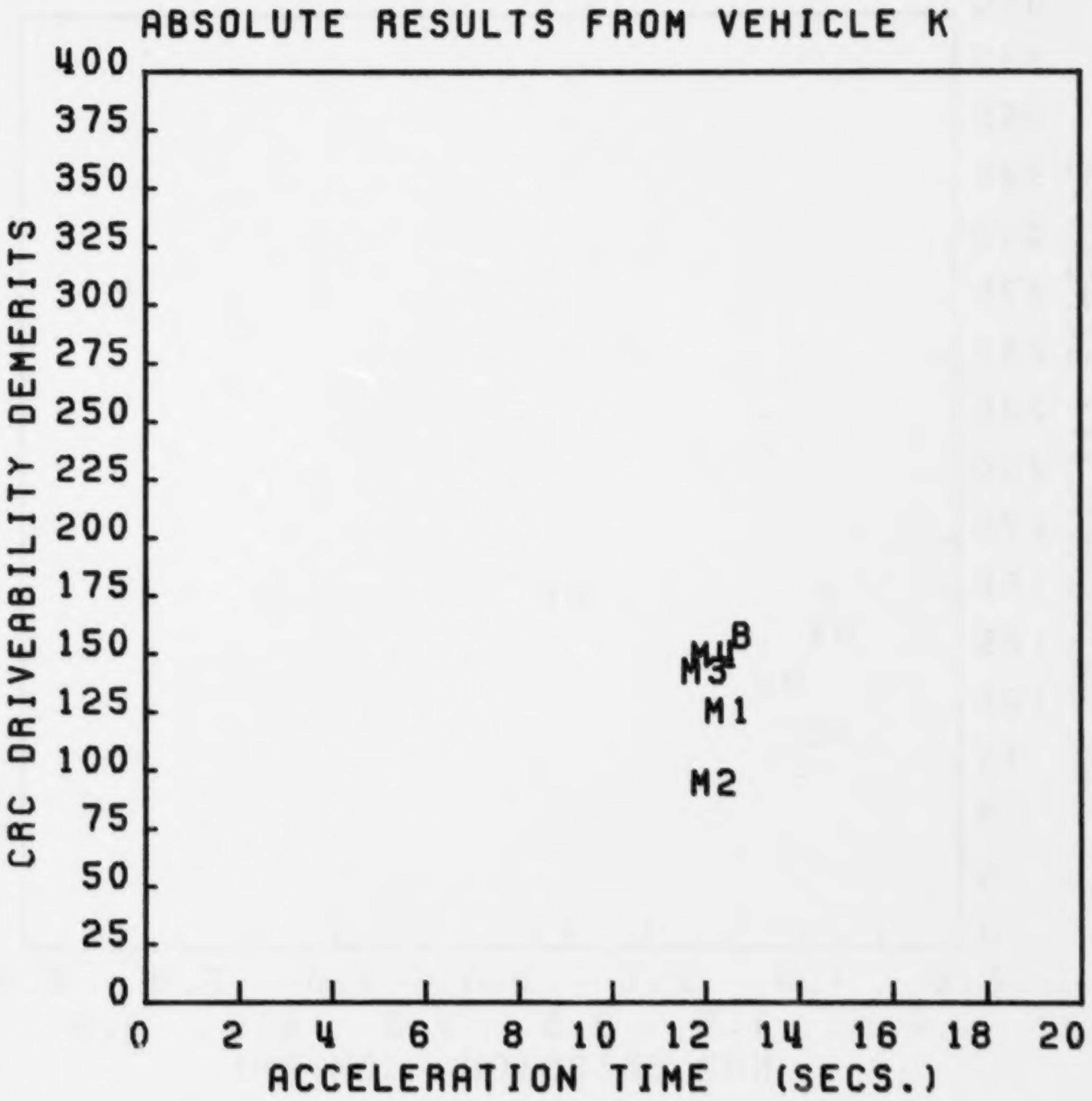

ABSOLUTE RESULTS FROM VEHICLE J
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1B
M4
M2
M3
0
2
4
6
8
10
12
14
16
18
20
22
24
26
HFET FUEL CONSUMPTION (L/1000KM)

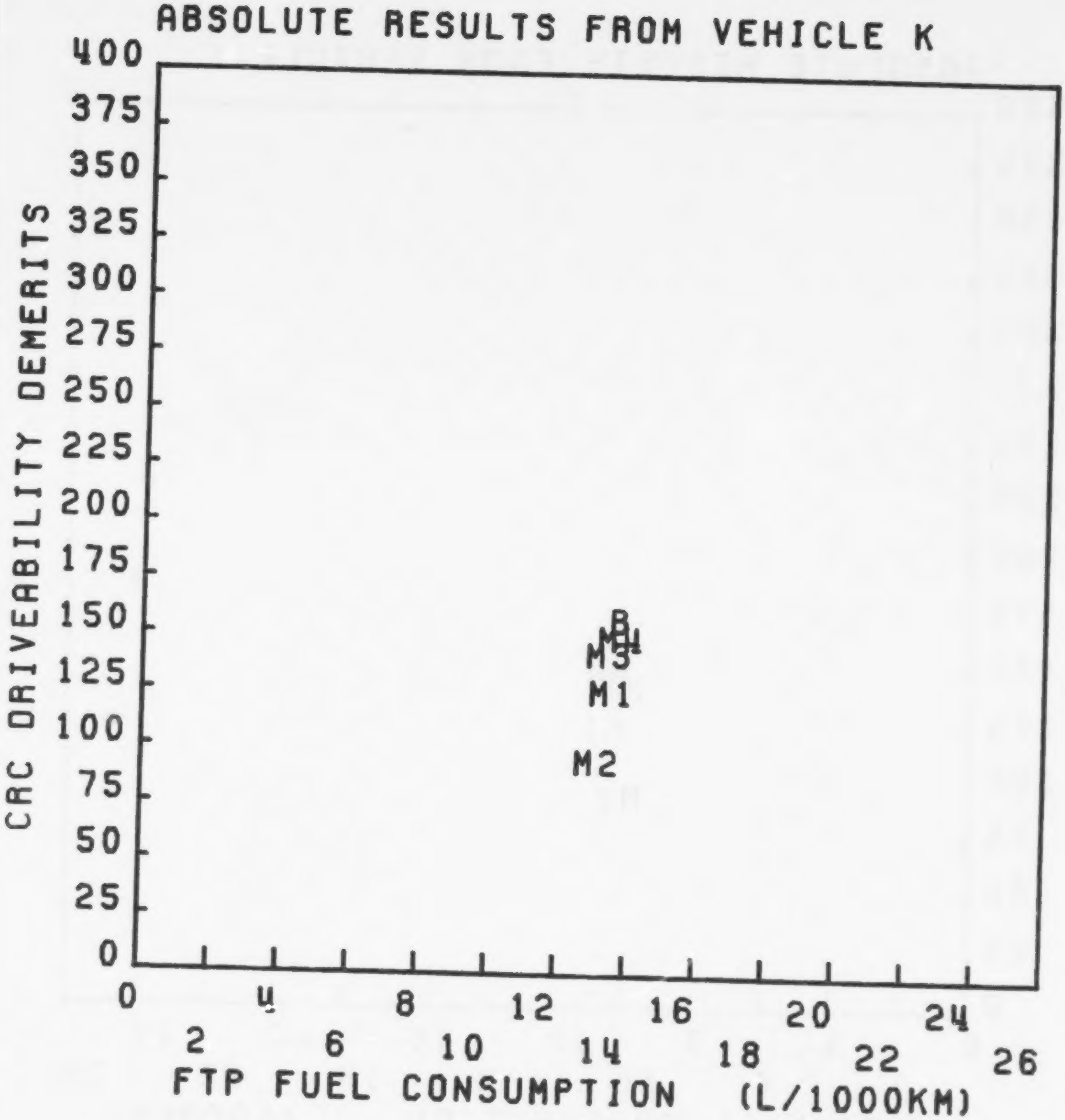

ABSOLUTE RESULTS FROM VEHICLE J
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M1
M4
M2
M3

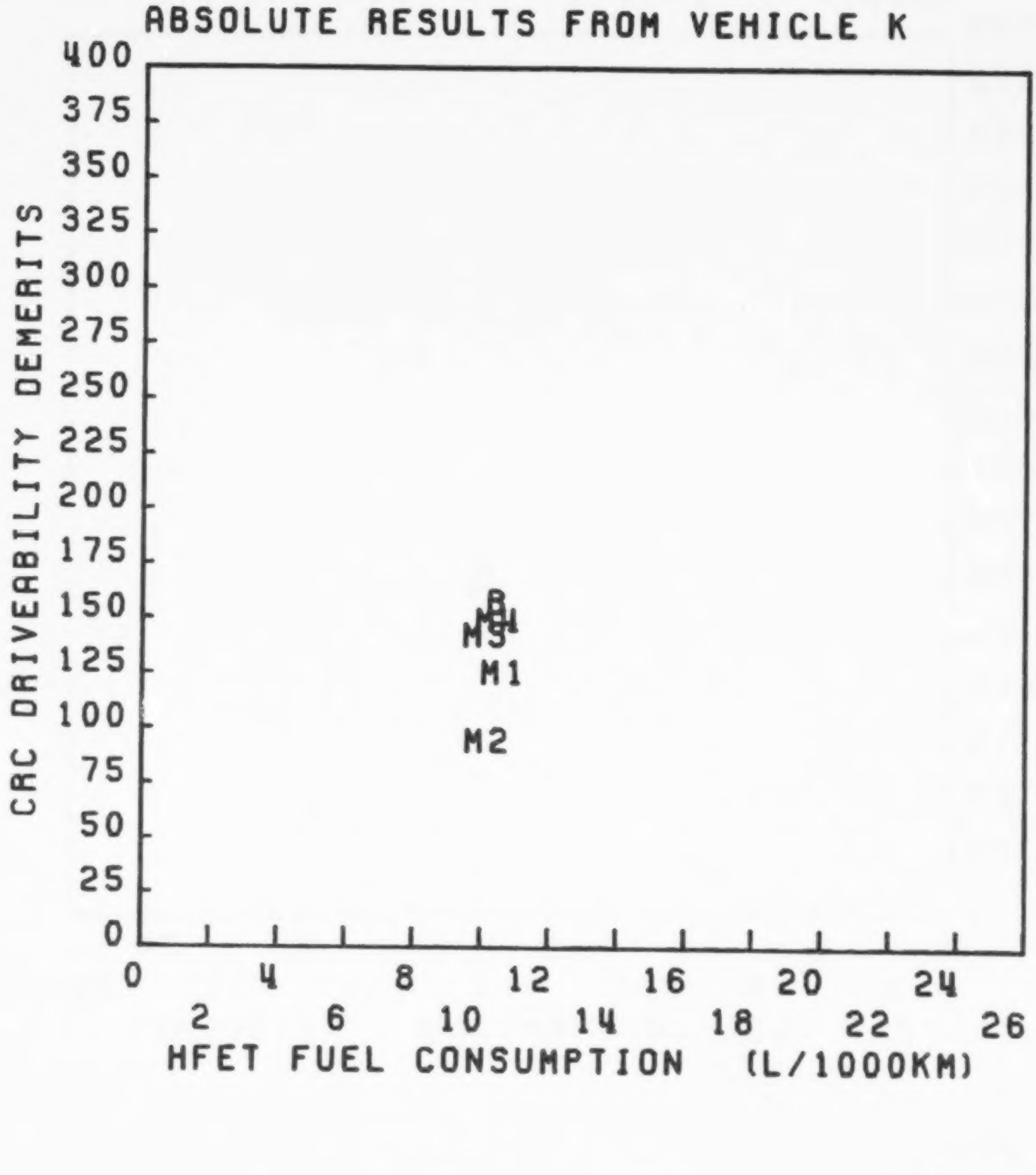
ABSOLUTE RESULTS FROM VEHICLE J

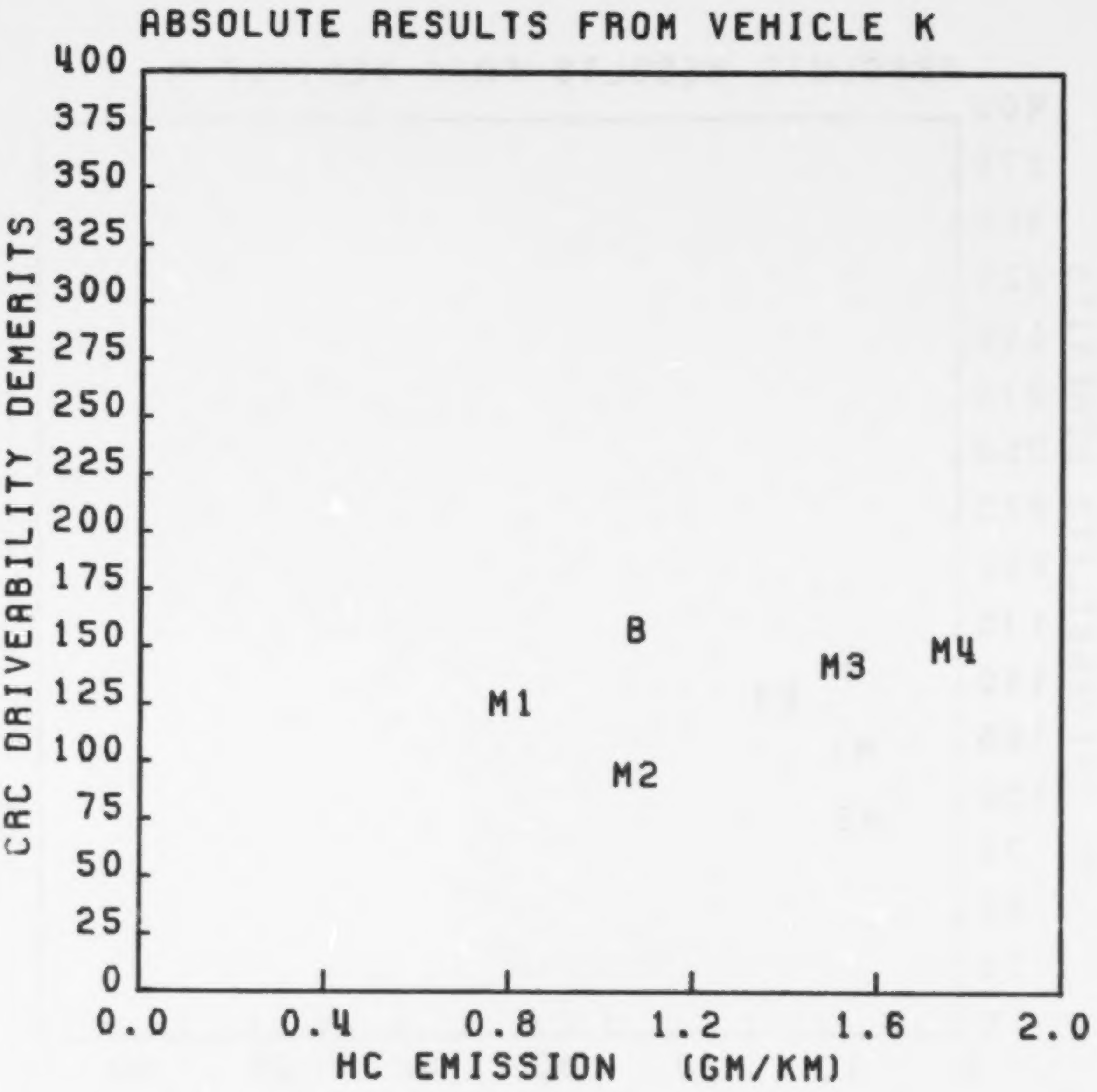


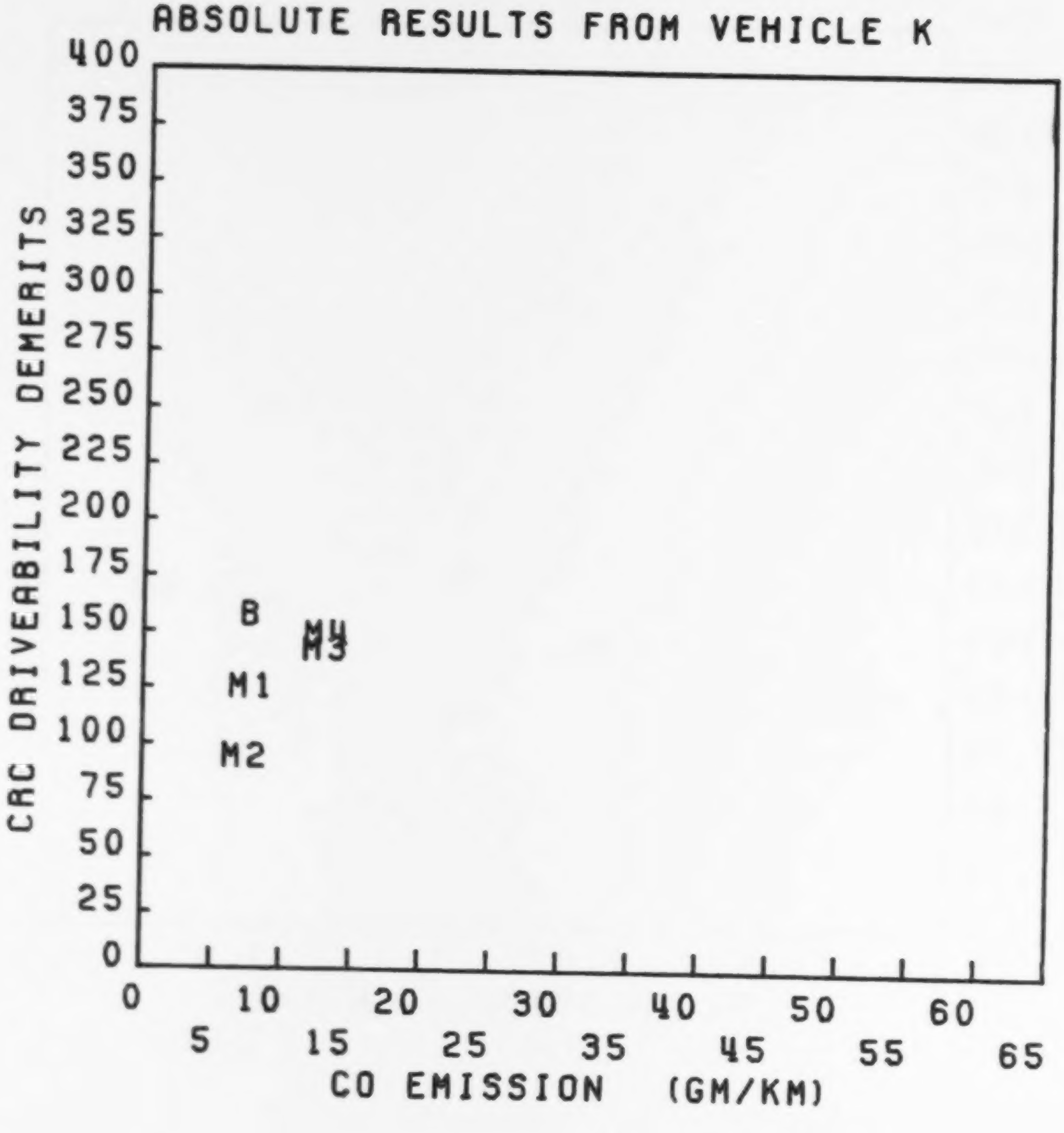

ABSOLUTE RESULTS FROM VEHICLE J
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
NOX EMISSION (GM/KM)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
B
M4
M2
M3
M1

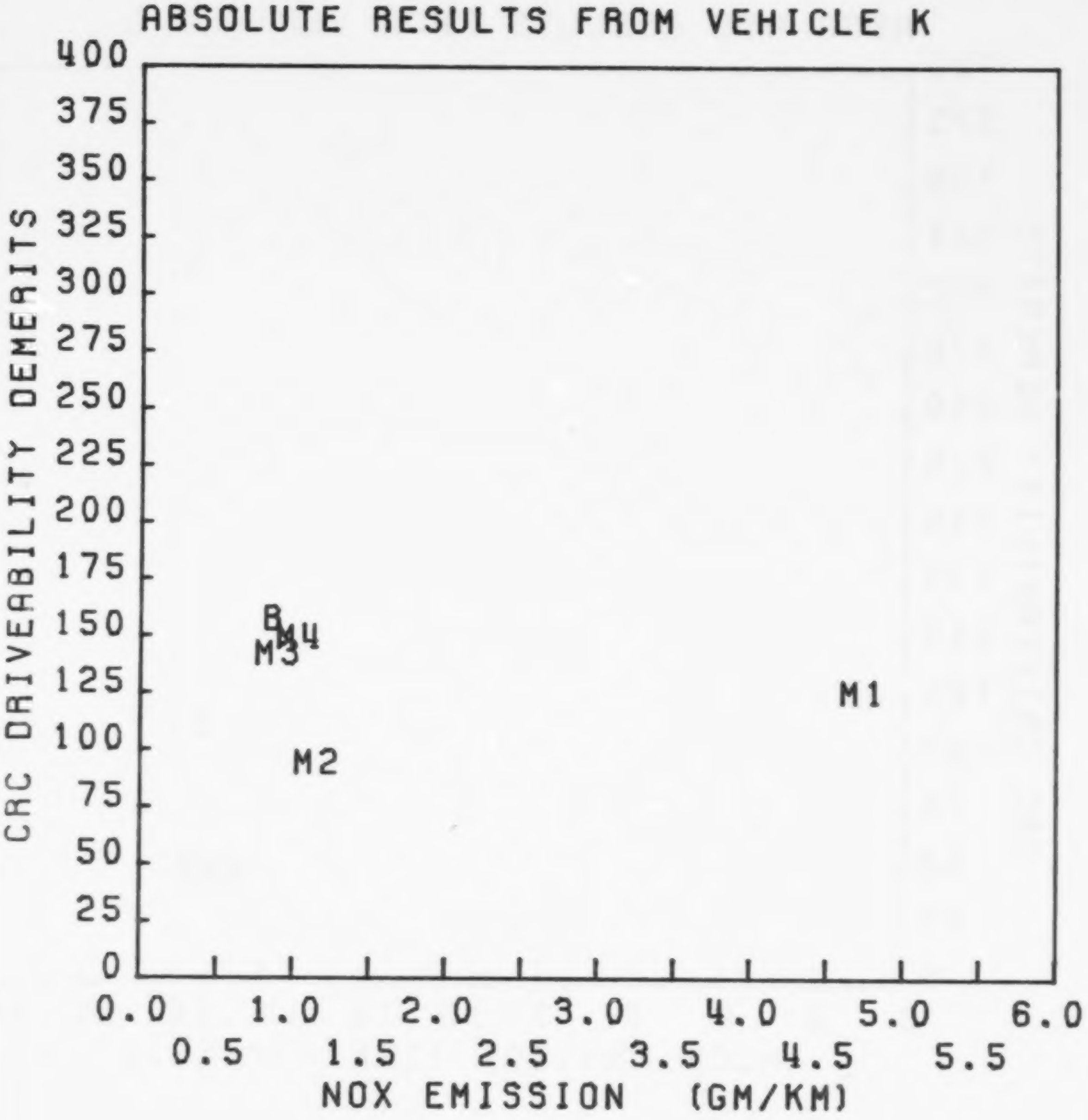

ABSOLUTE RESULTS FROM VEHICLE K
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
ACCELERATION TIME (SECS.)
0
2
4
6
8
10
12
14
16
18
20
M4
B
M3
M1
M2


ABSOLUTE RESULTS FROM VEHICLE K
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M4
M3
M1
M2
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)

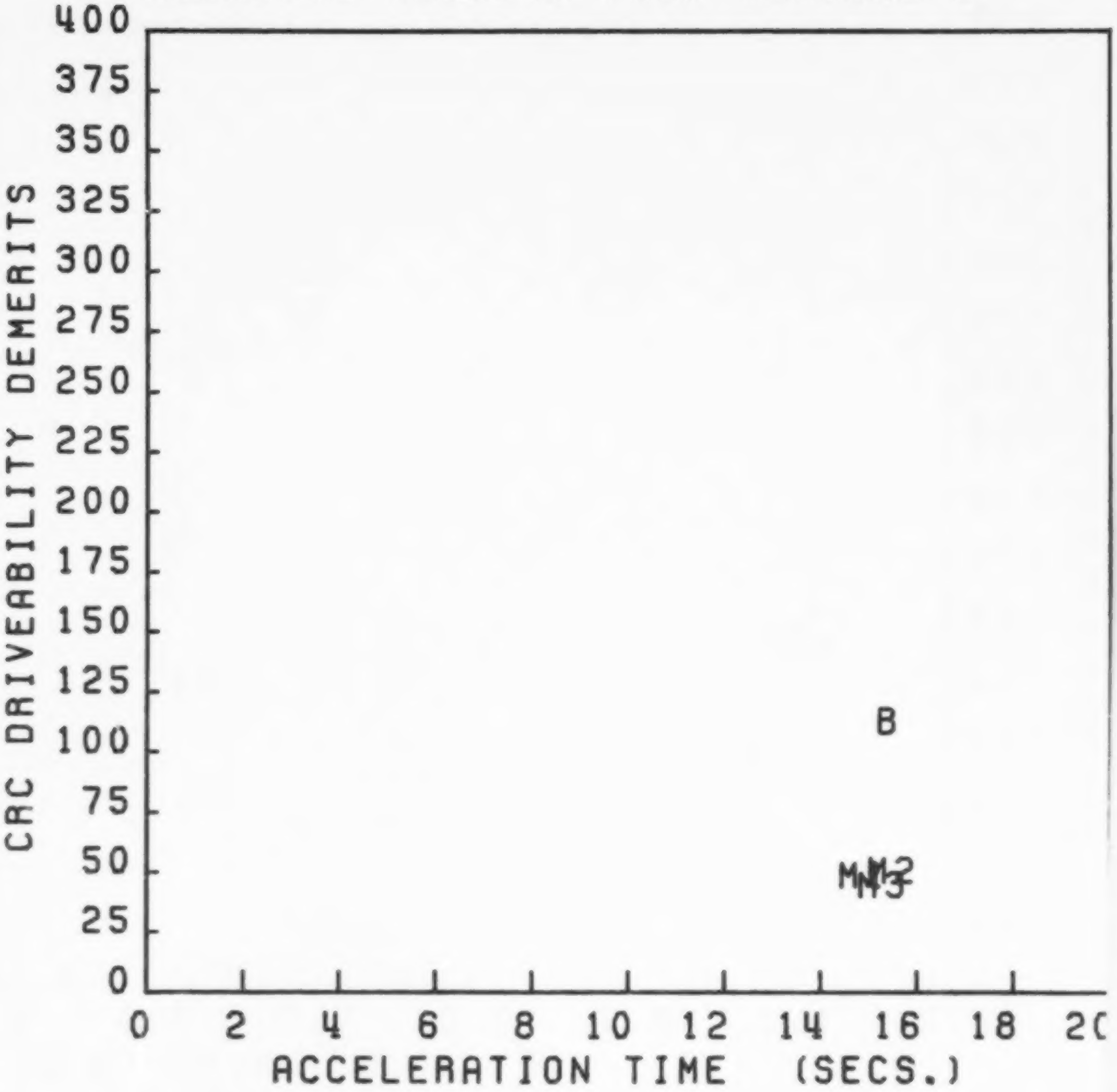

ABSOLUTE RESULTS FROM VEHICLE K
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
HFET FUEL CONSUMPTION (L/1000KM)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
B
M4
M3
M1
M2

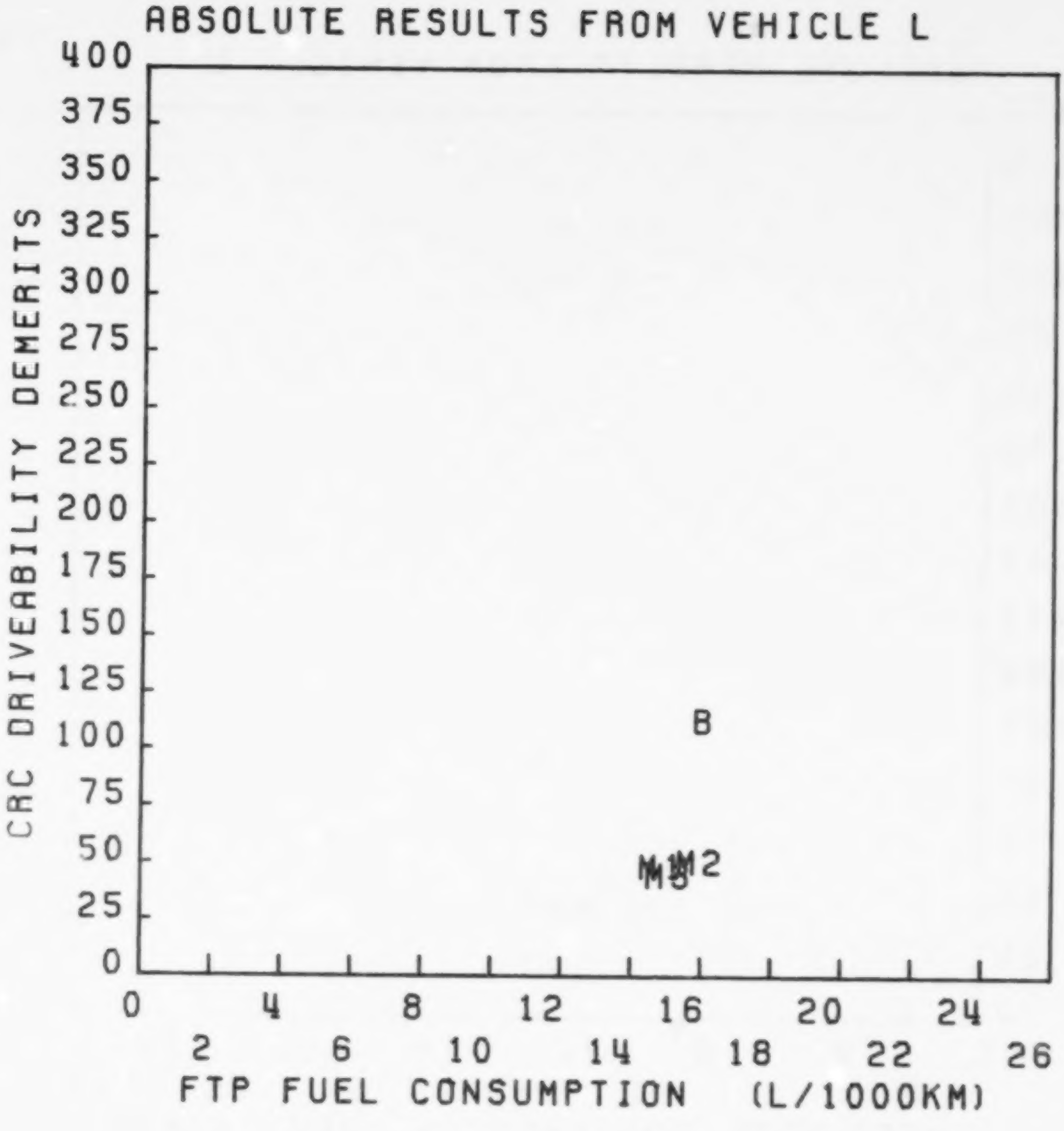

ABSOLUTE RESULTS FROM VEHICLE K
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
B
M1
M2
M3
M4

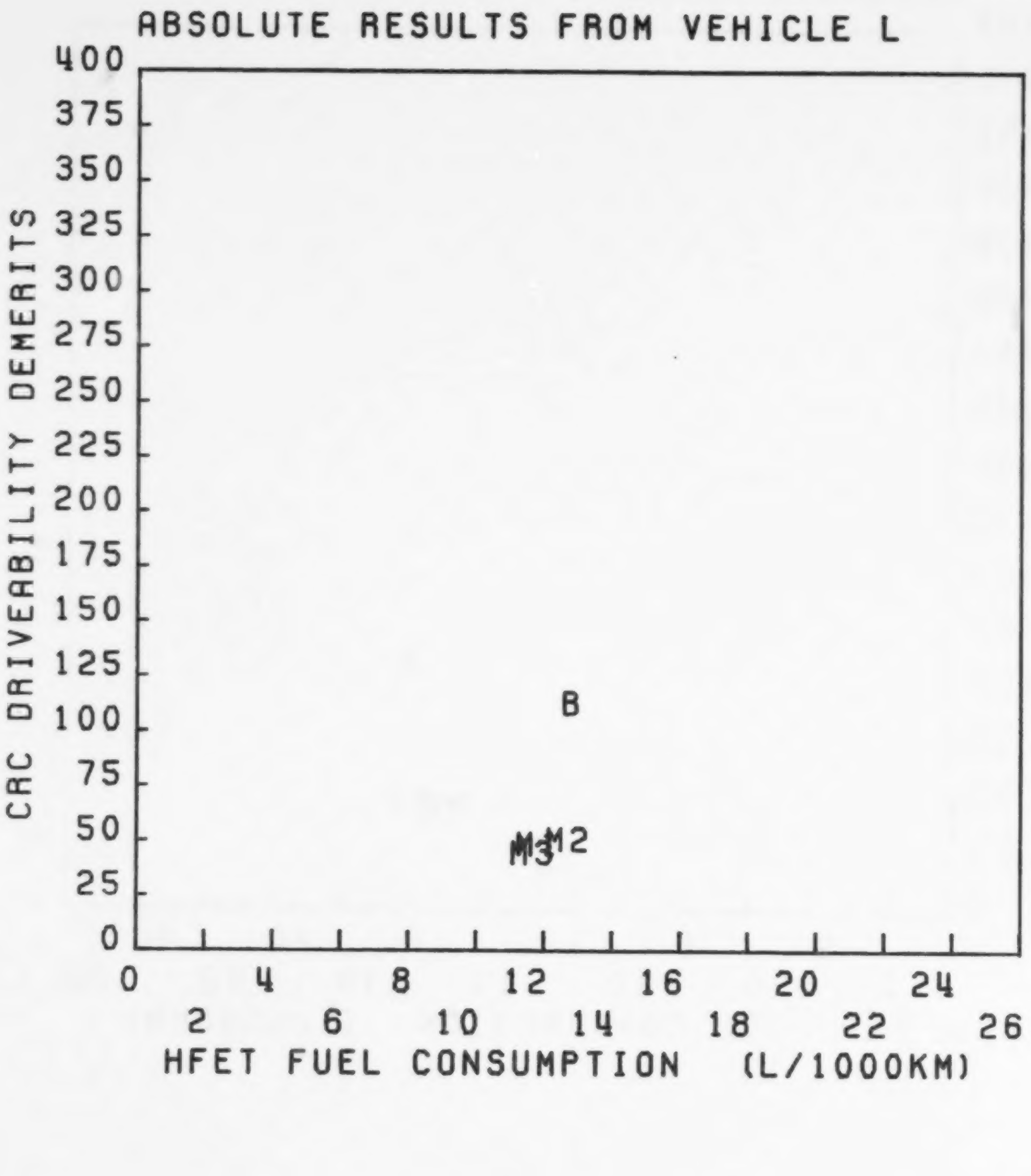

ABSOLUTE RESULTS FROM VEHICLE K
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M4
M3
M1
M2
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

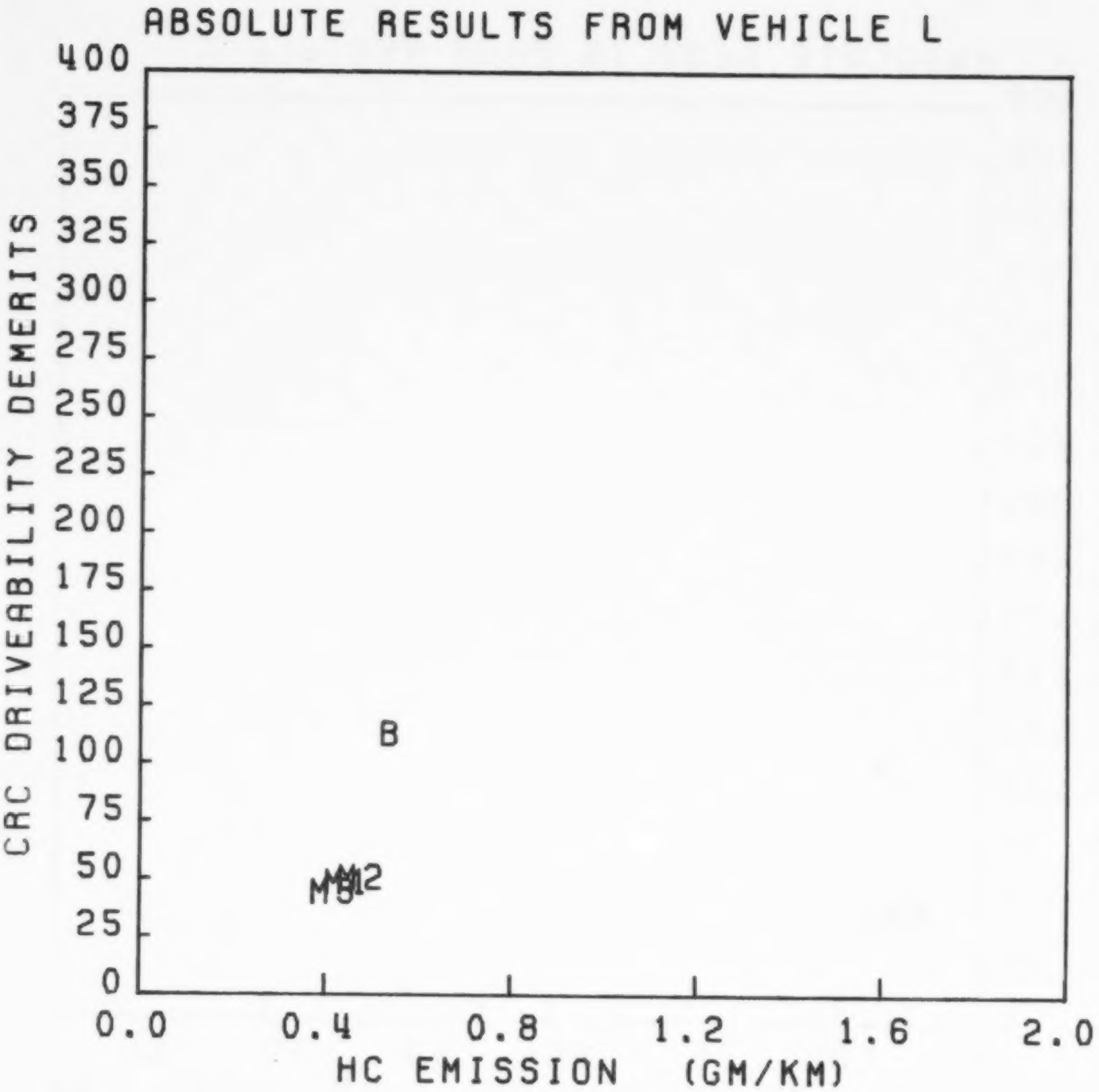

ABSOLUTE RESULTS FROM VEHICLE K
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M4
M3
M2
M1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

ABSOLUTE RESULTS FROM VEHICLE L

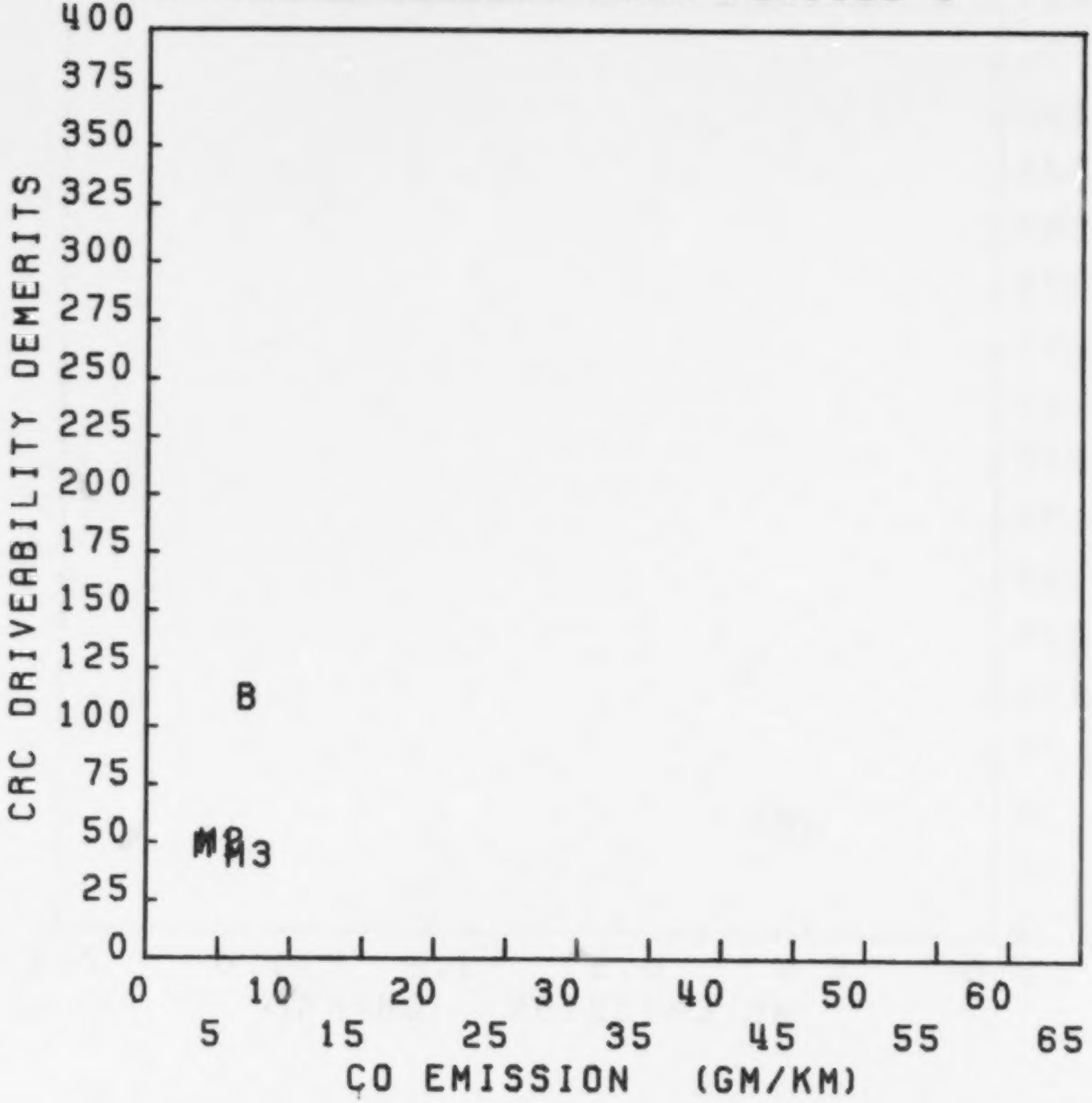


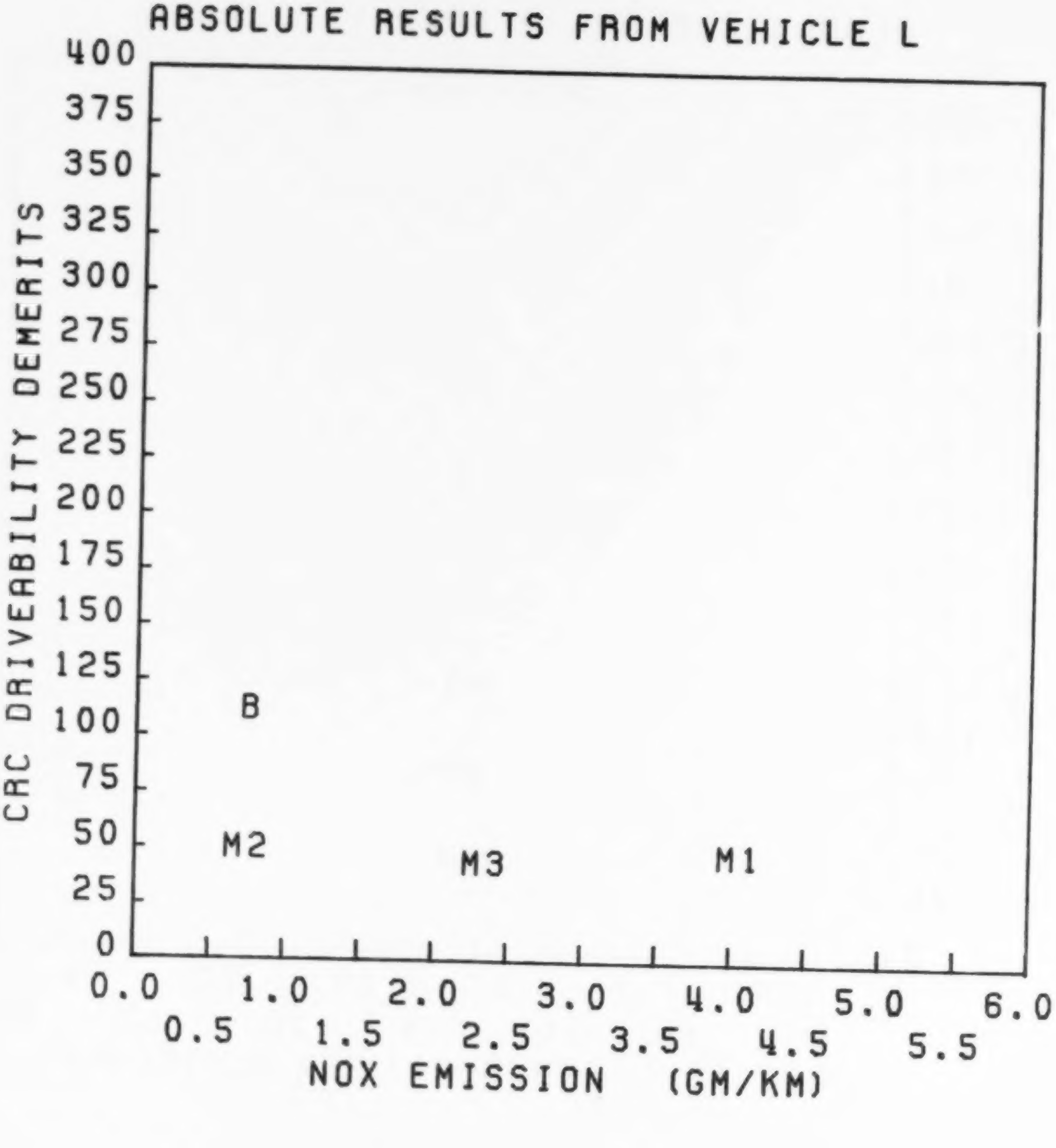

ABSOLUTE RESULTS FROM VEHICLE L
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
FTP FUEL CONSUMPTION (L/1000KM)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
B
M1
M2
M3

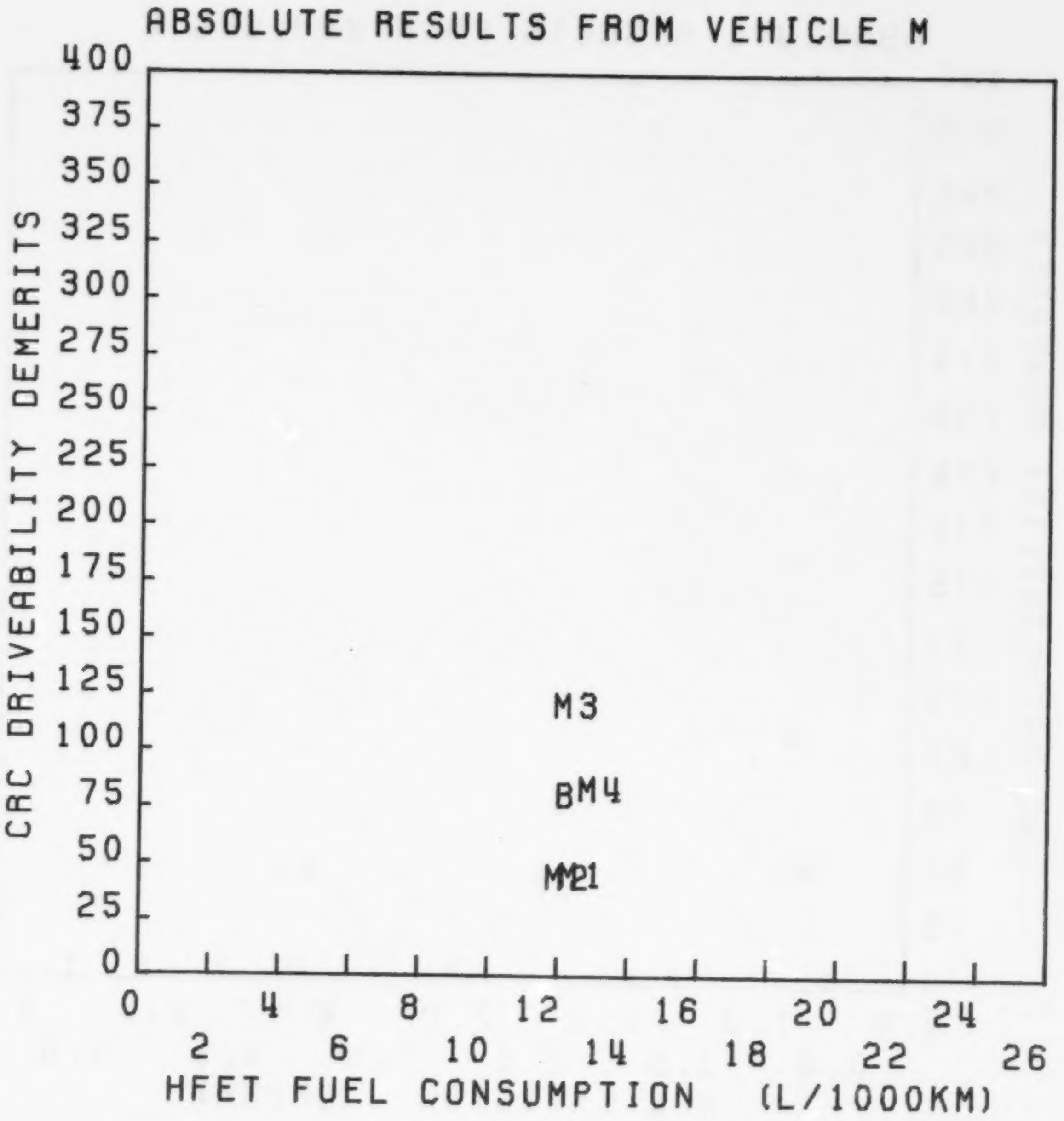

ABSOLUTE RESULTS FROM VEHICLE L
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M
M2
M3
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)


ABSOLUTE RESULTS FROM VEHICLE L
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M5
M1
M2
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)

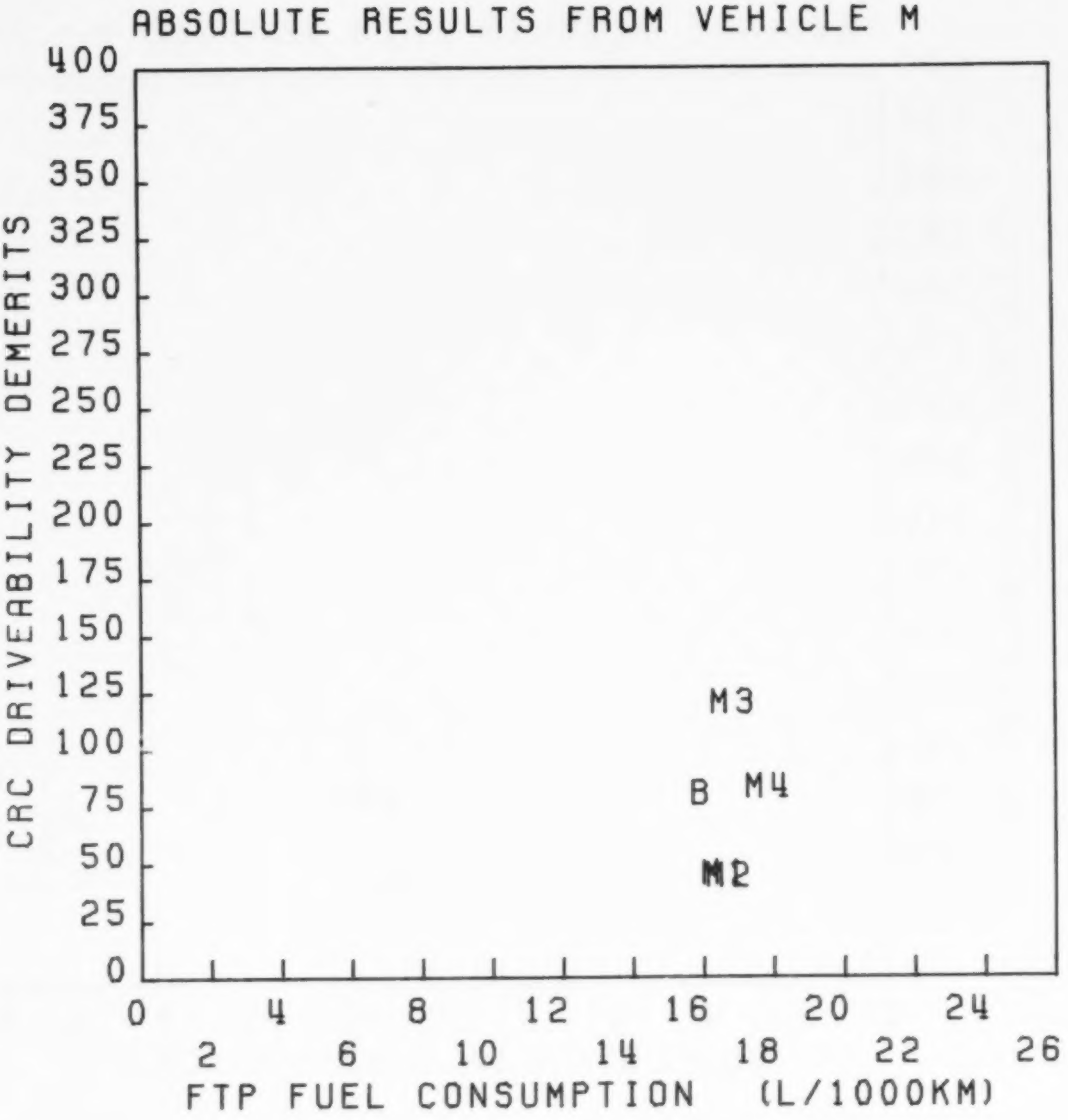
ABSOLUTE RESULTS FROM VEHICLE L



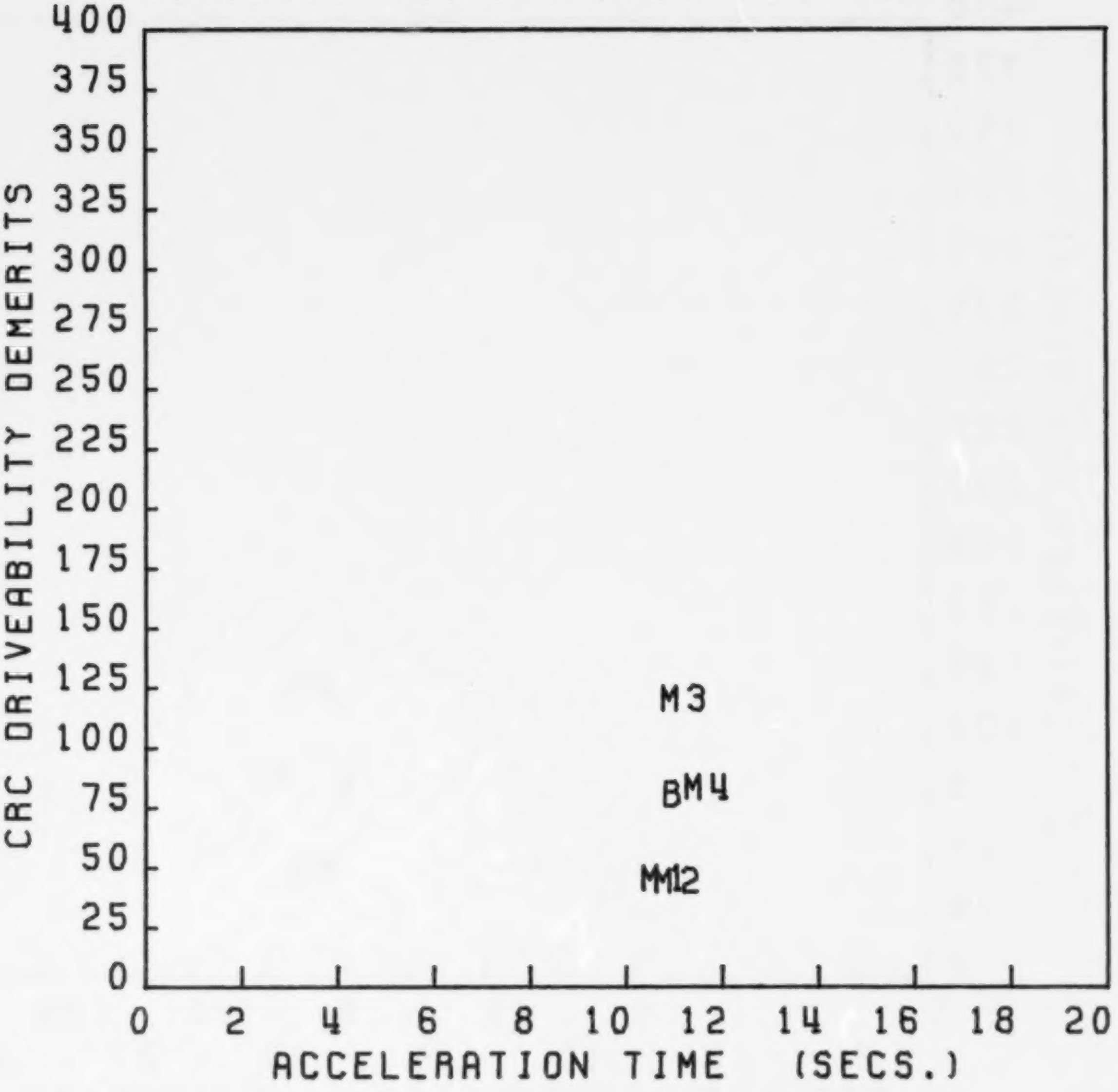

ABSOLUTE RESULTS FROM VEHICLE L
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M2
M3
M1
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)

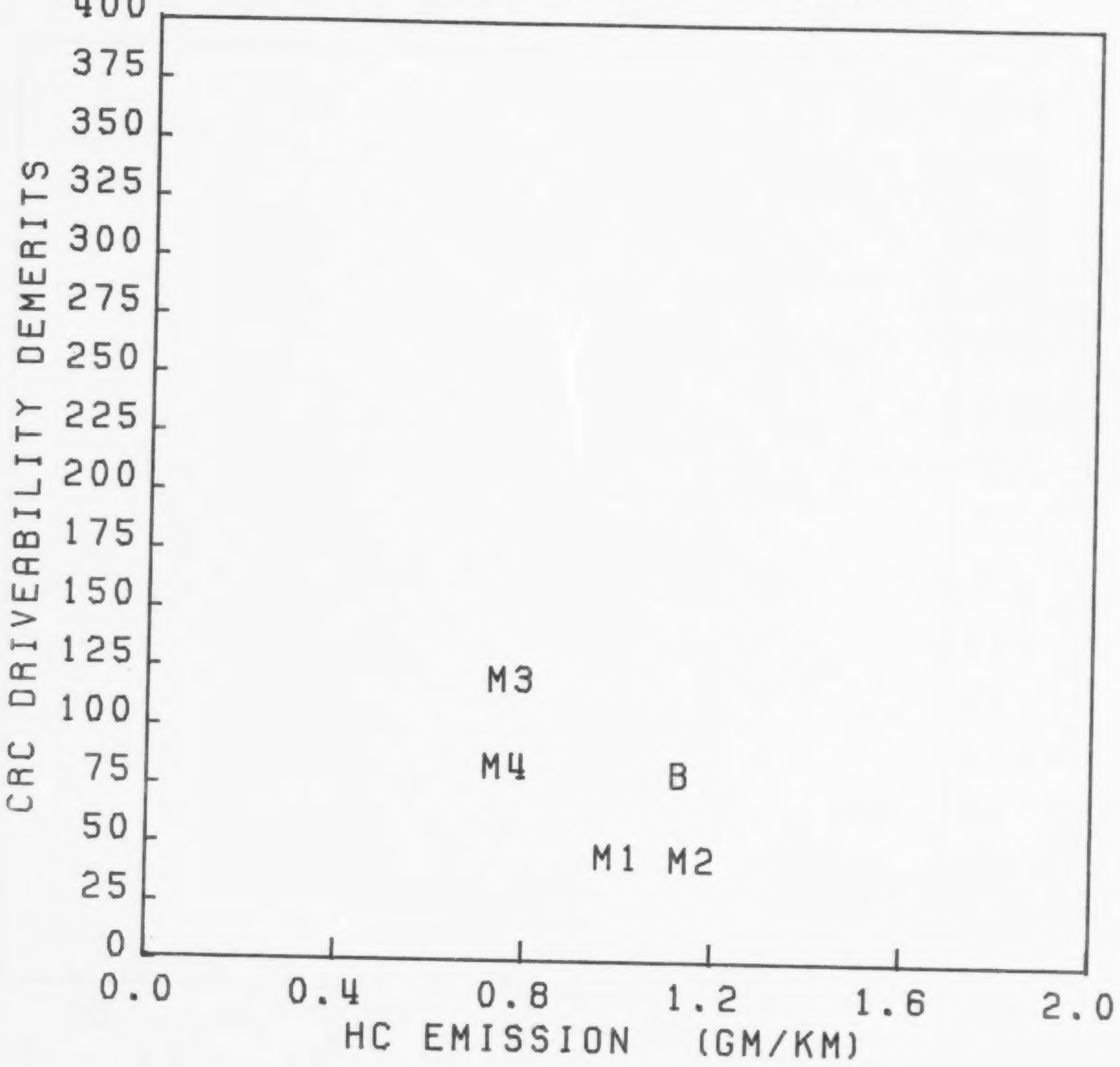


ABSOLUTE RESULTS FROM VEHICLE M

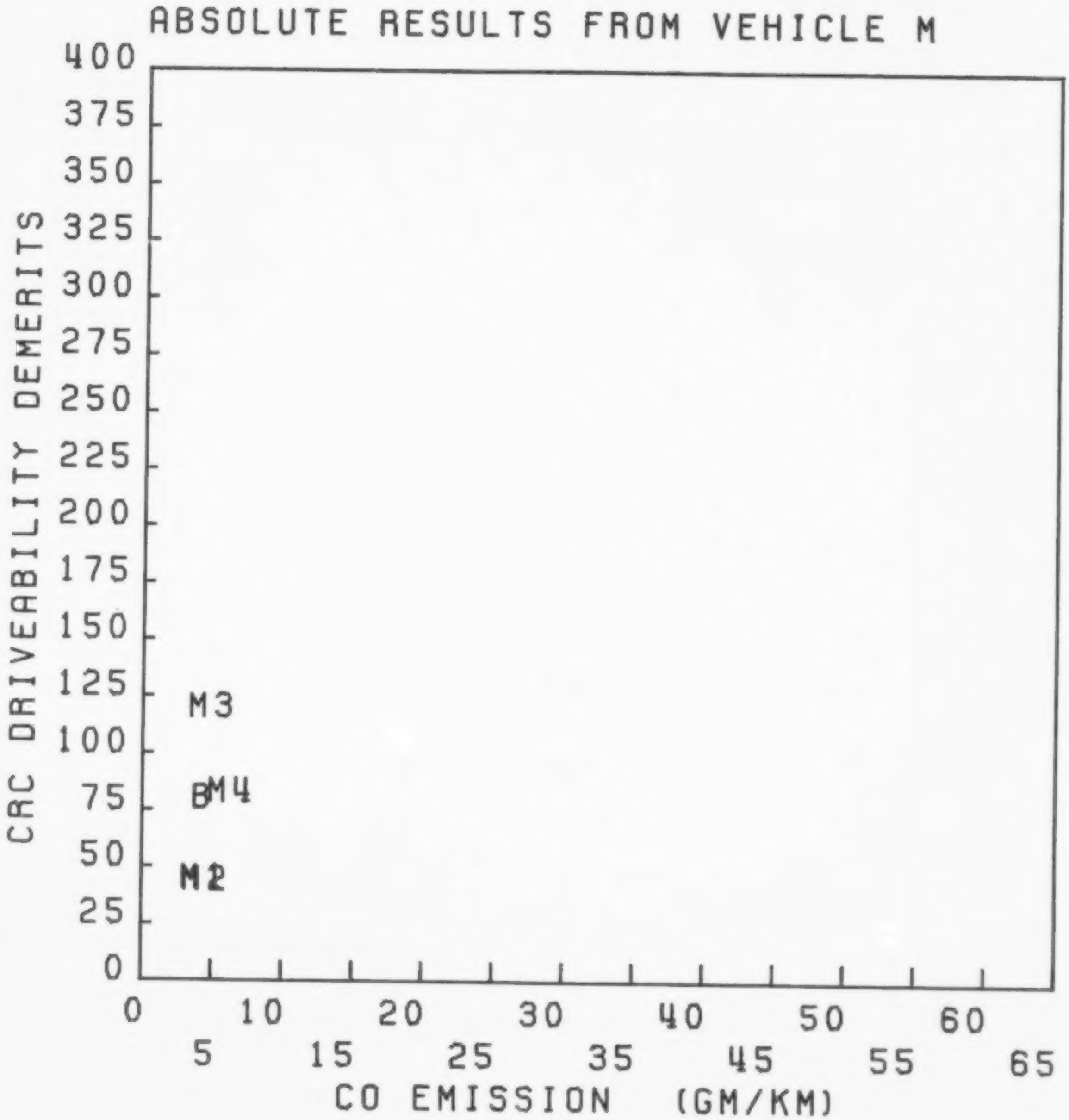

ABSOLUTE RESULTS FROM VEHICLE M

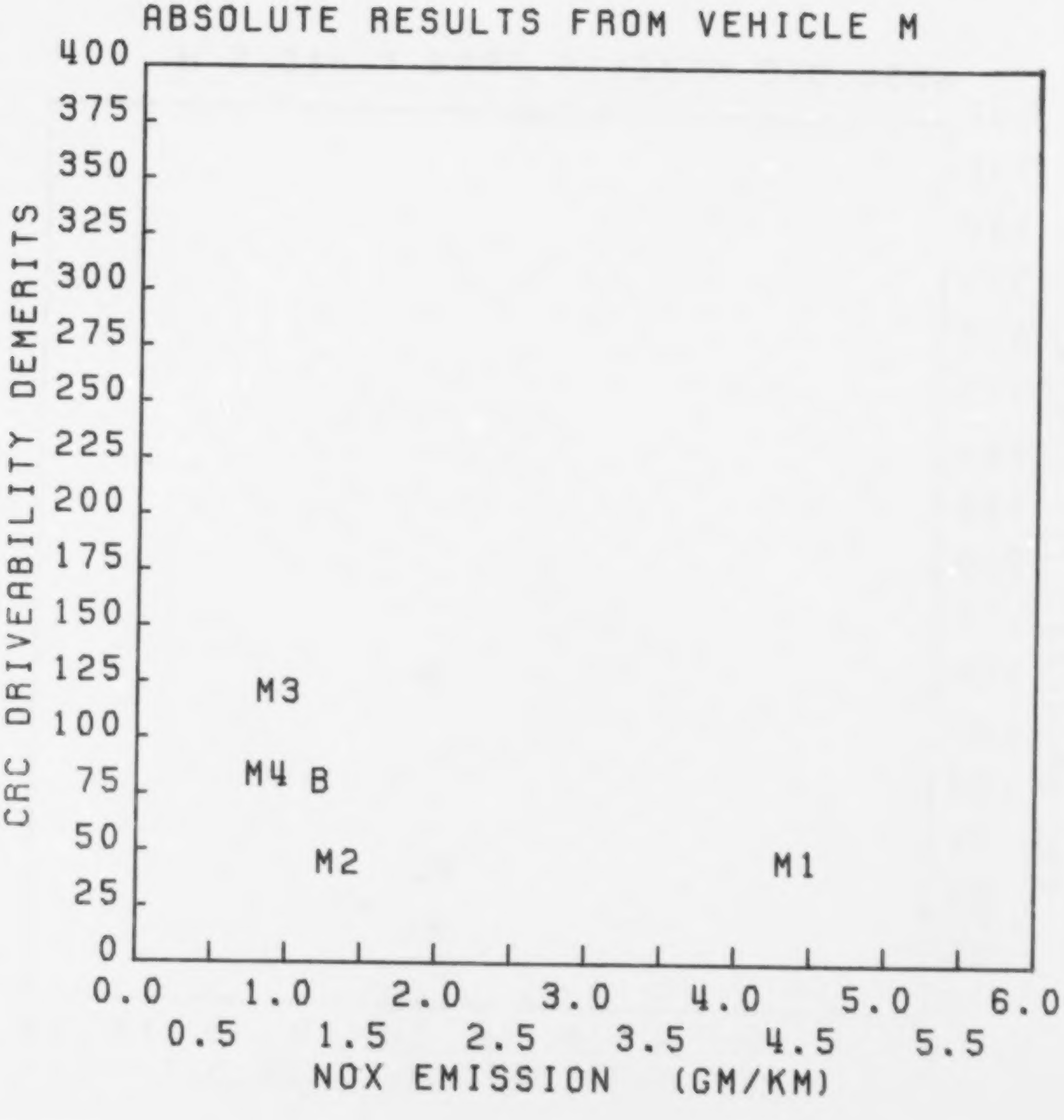
ABSOLUTE RESULTS FROM VEHICLE M

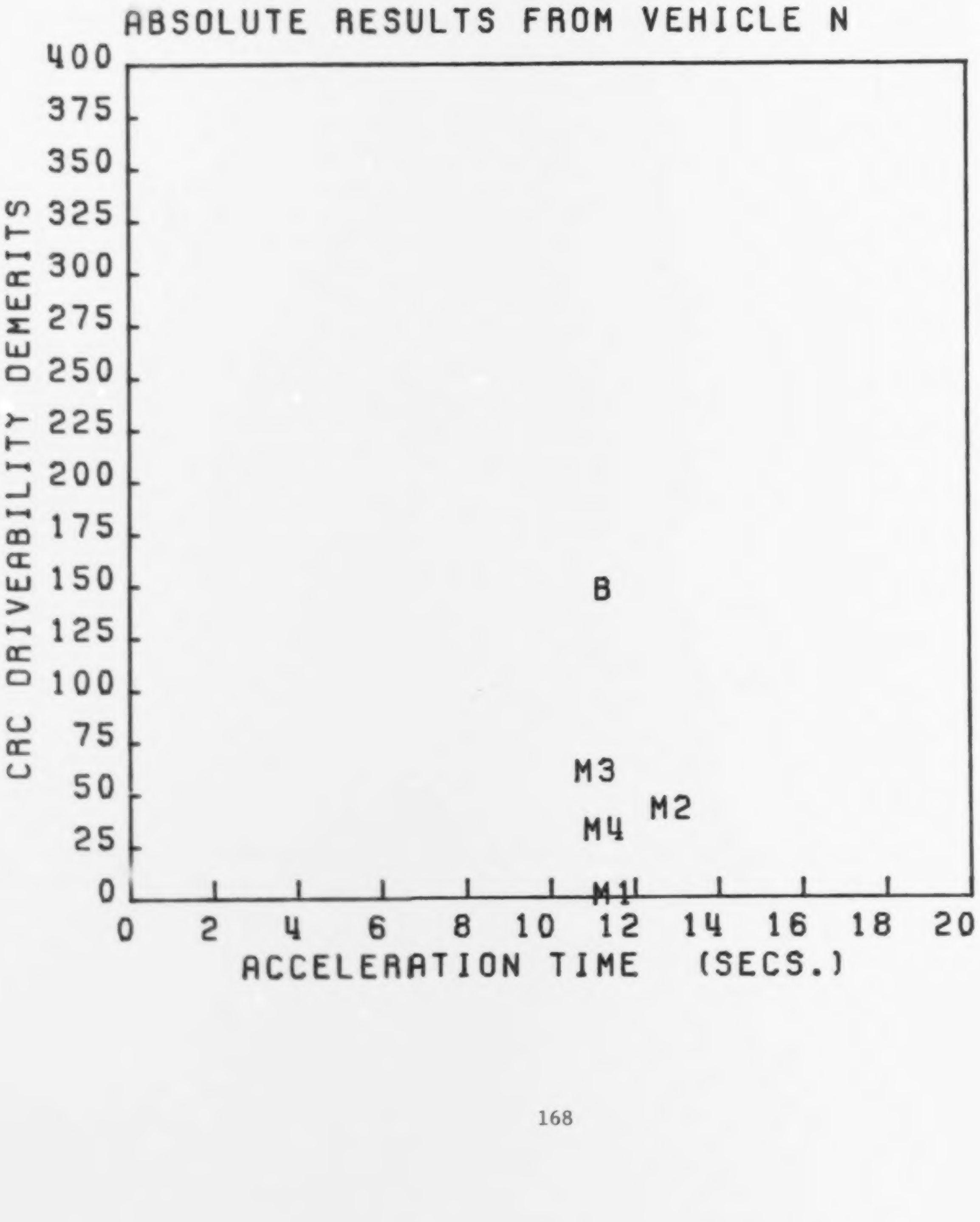


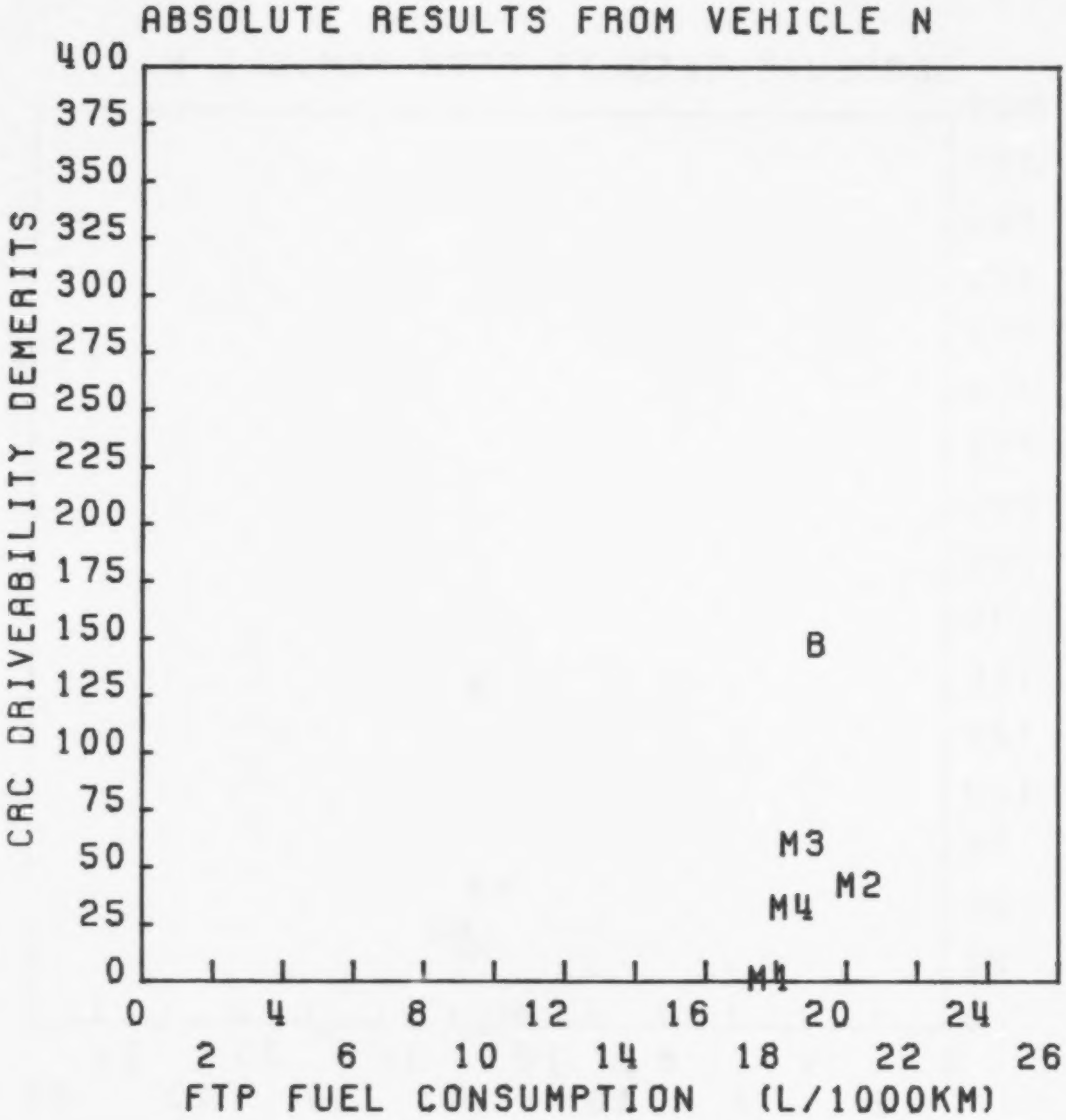


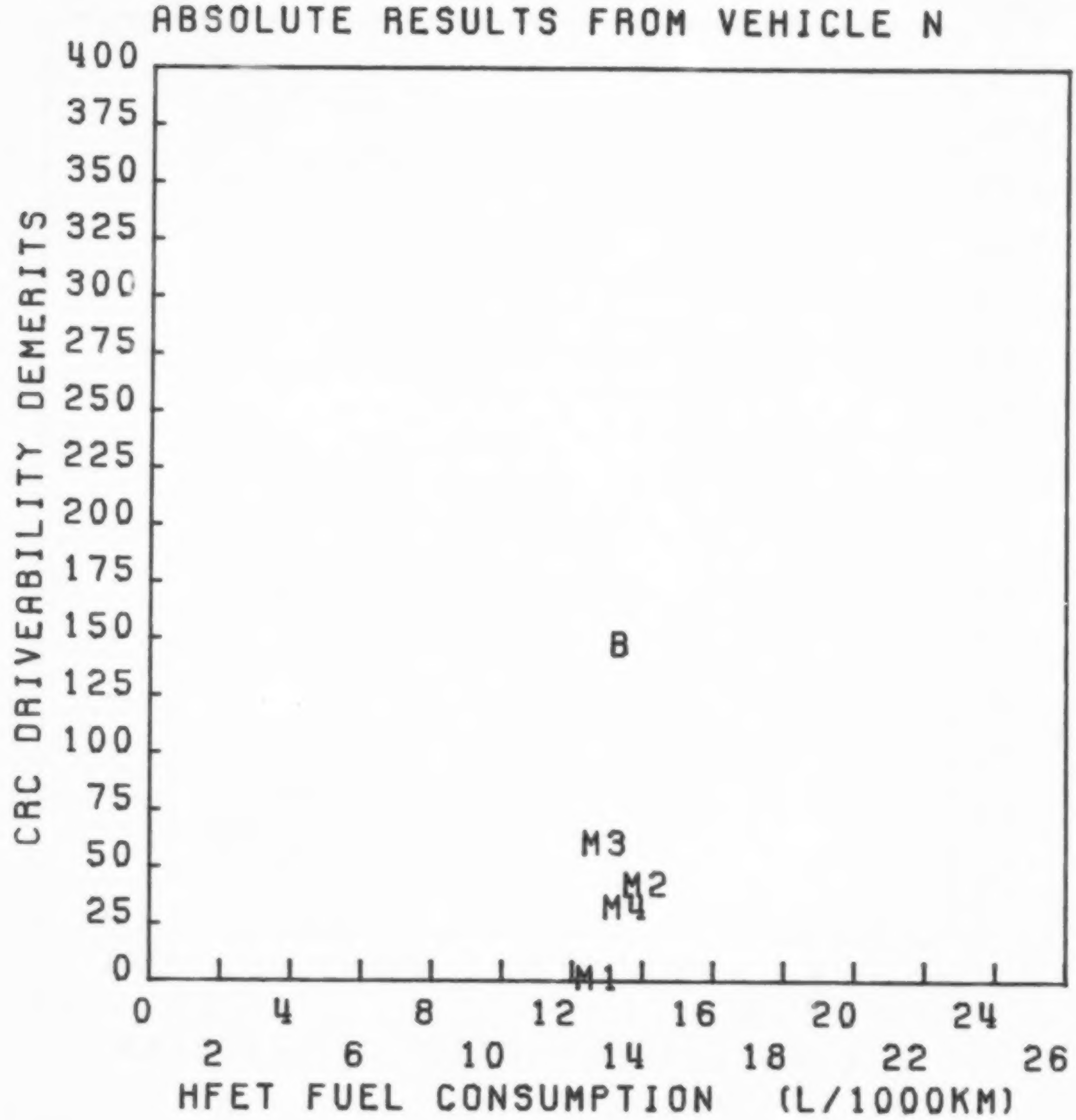
ABSOLUTE RESULTS FROM VEHICLE M

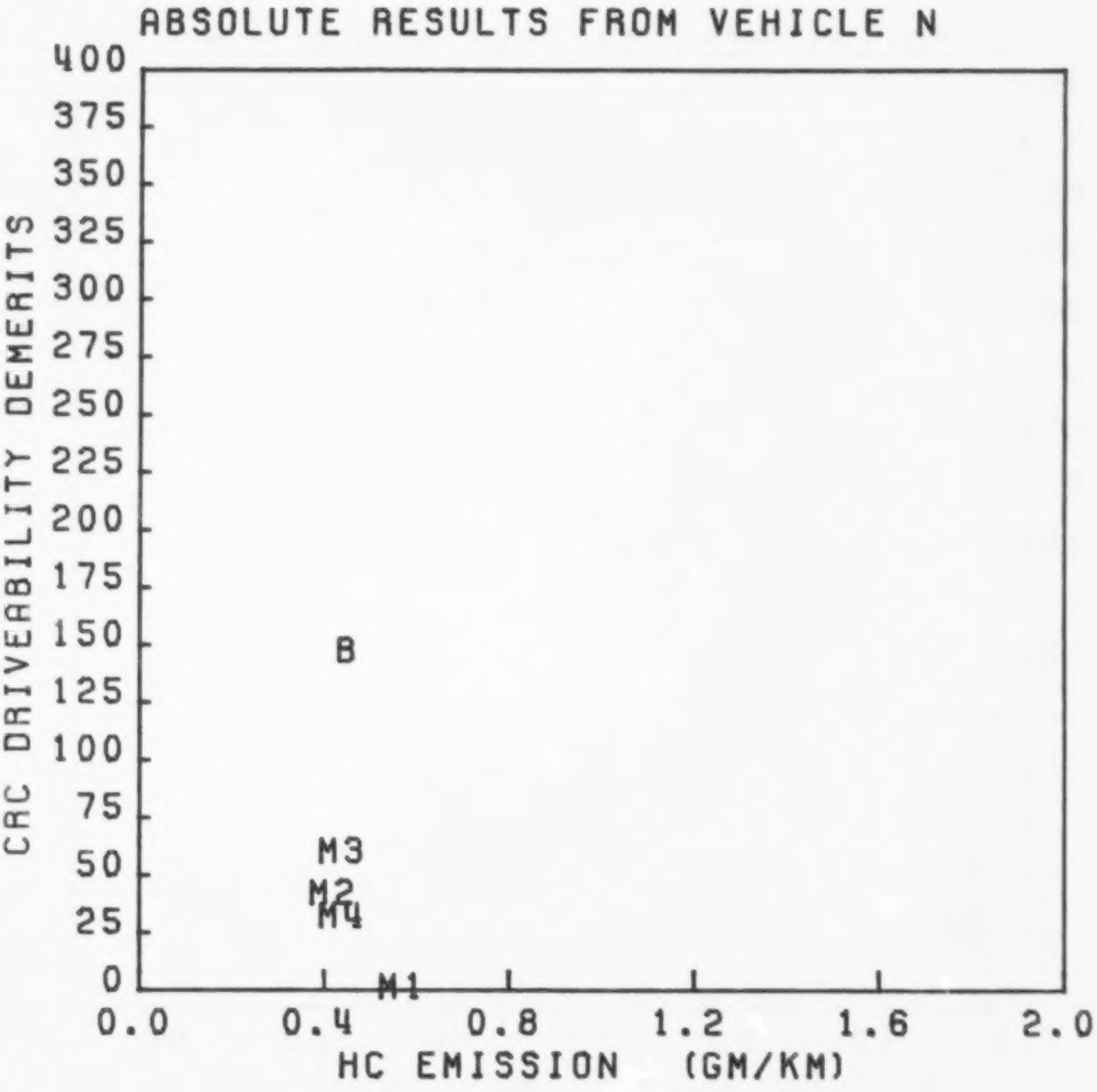

ABSOLUTE RESULTS FROM VEHICLE M
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
CO EMISSION (GM/KM)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
M3
B
M4
M1
M2

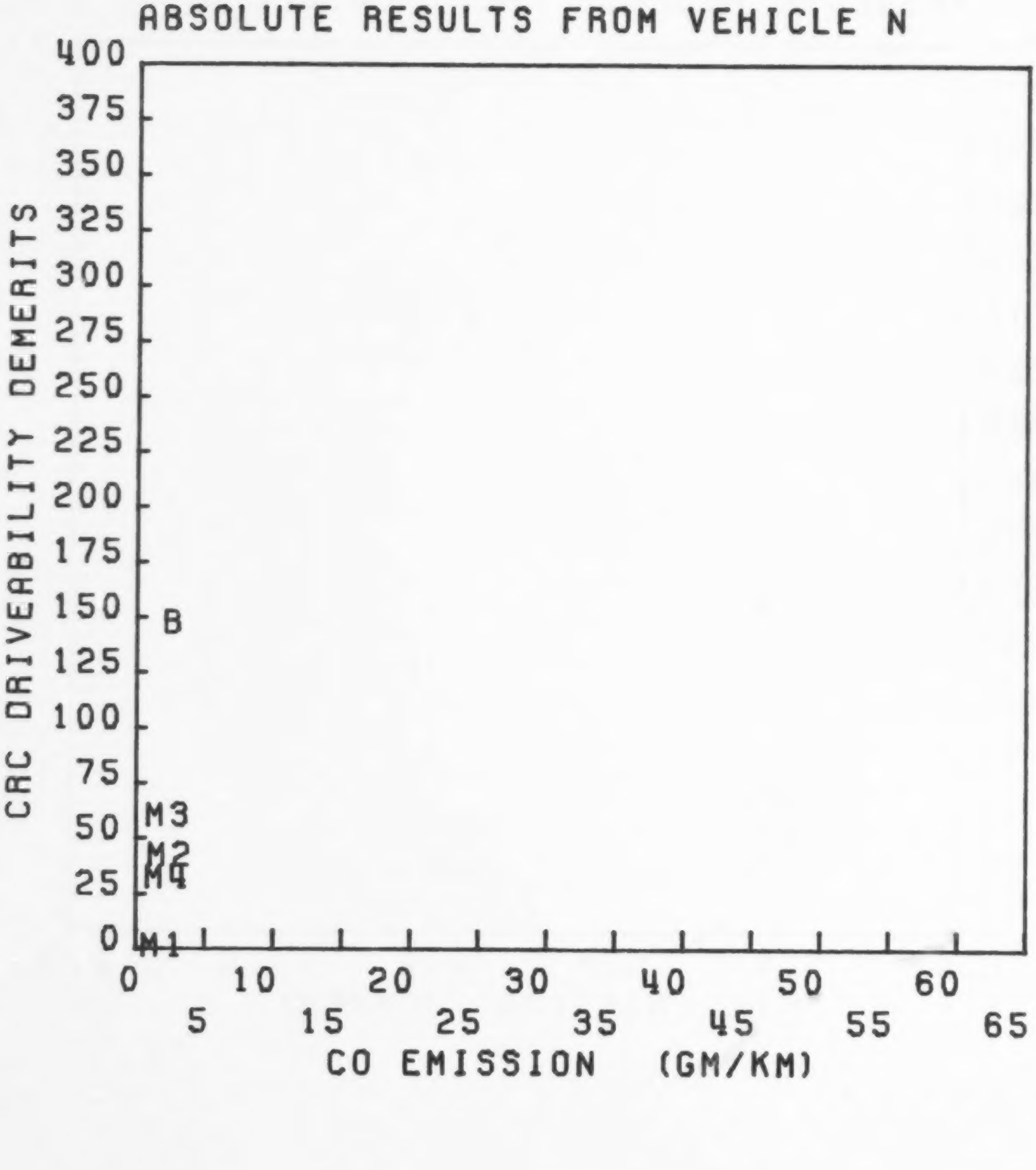

ABSOLUTE RESULTS FROM VEHICLE M
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M4
B
M2
M1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

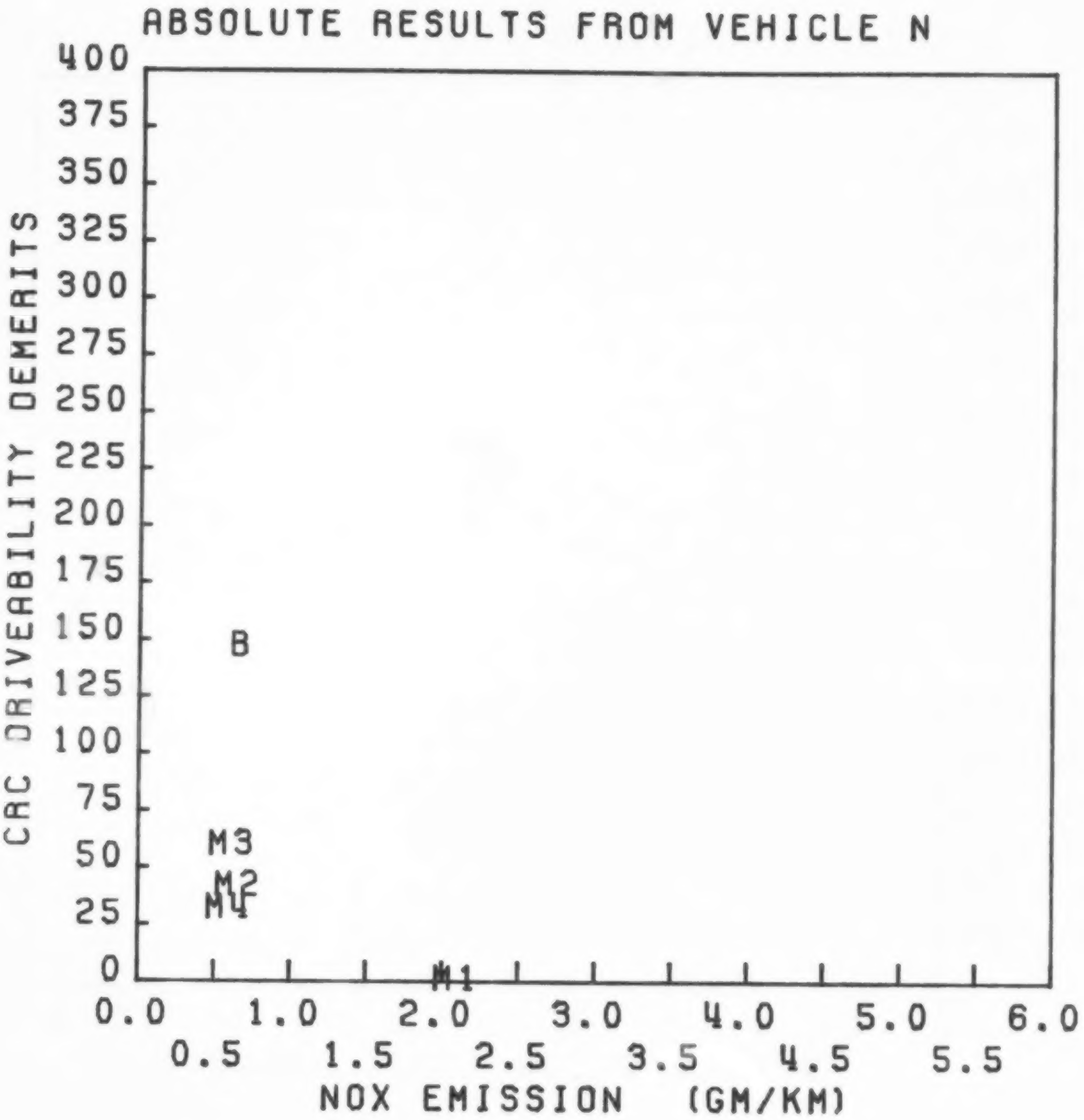

ABSOLUTE RESULTS FROM VEHICLE N
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)

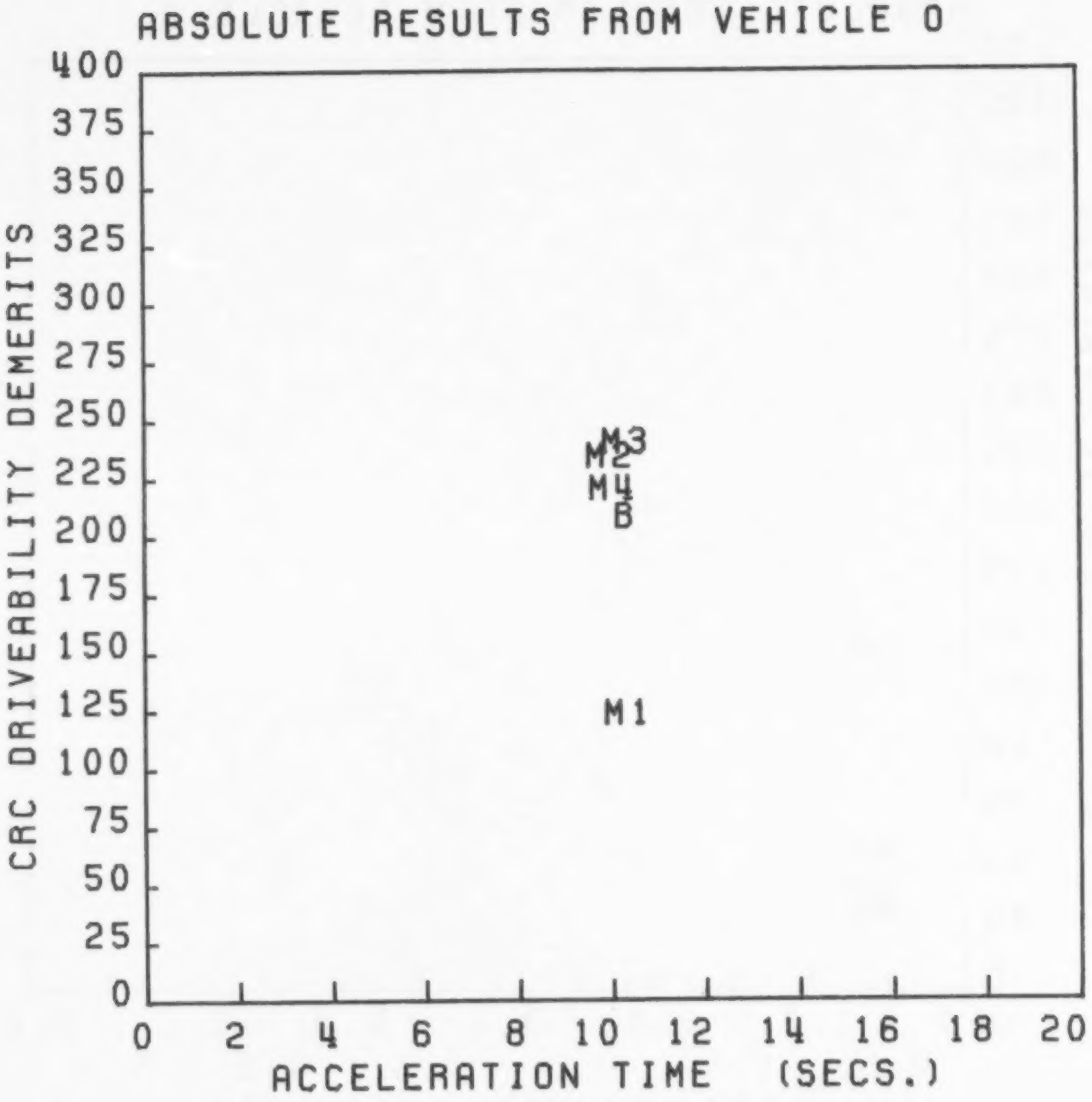

ABSOLUTE RESULTS FROM VEHICLE N
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)

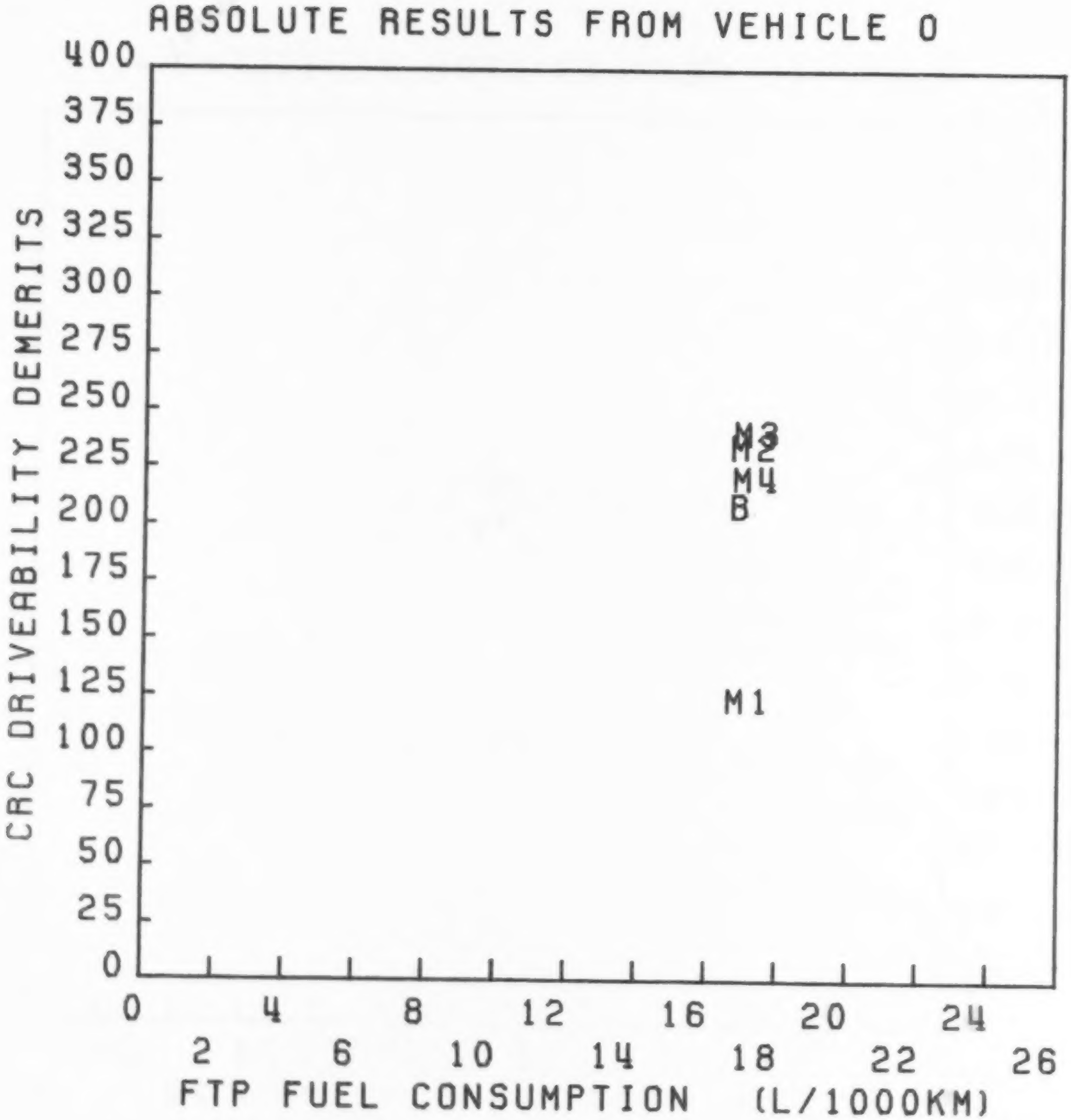

ABSOLUTE RESULTS FROM VEHICLE N
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

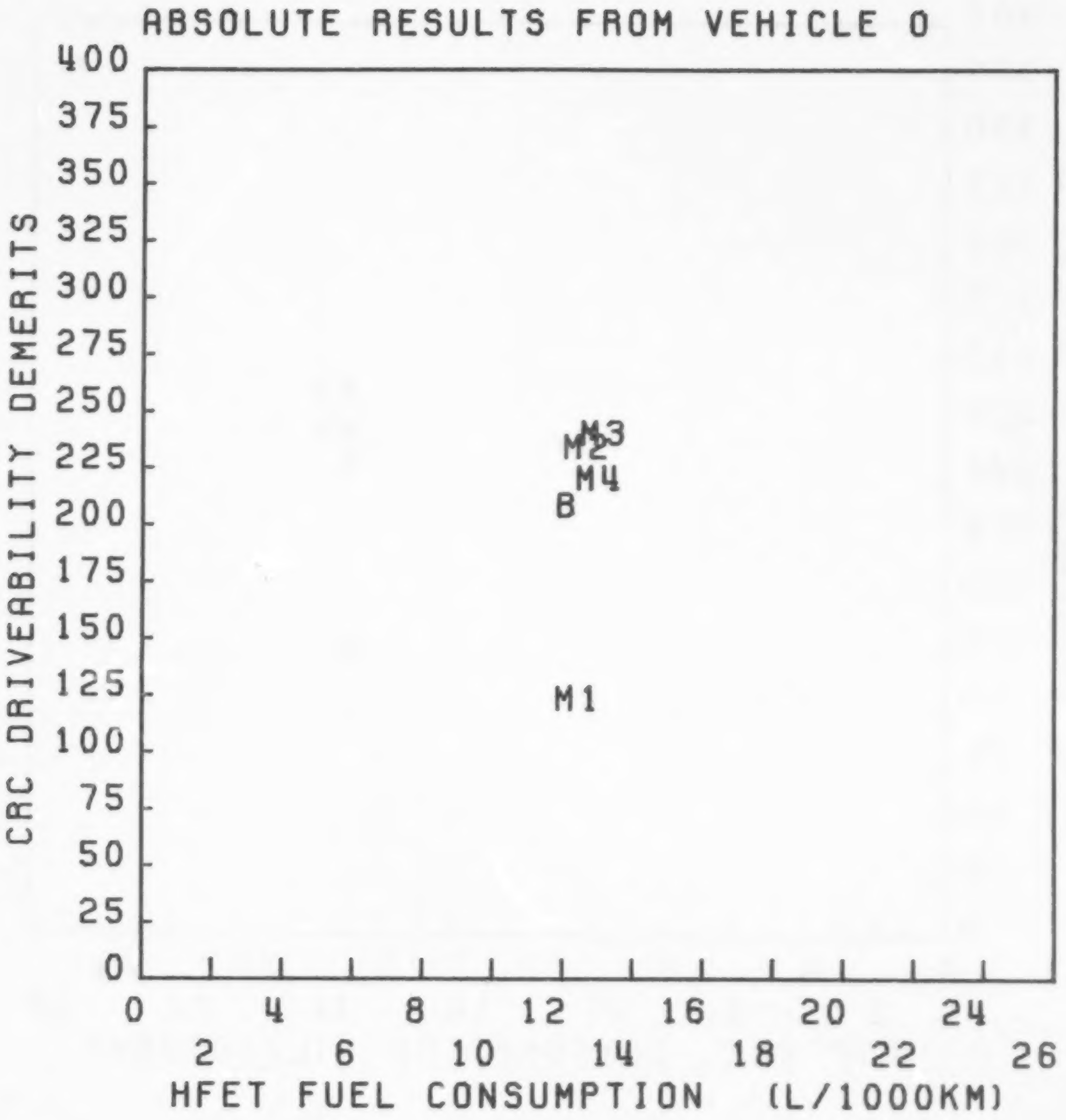

ABSOLUTE RESULTS FROM VEHICLE N
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
B
M3
M2
M4
M1

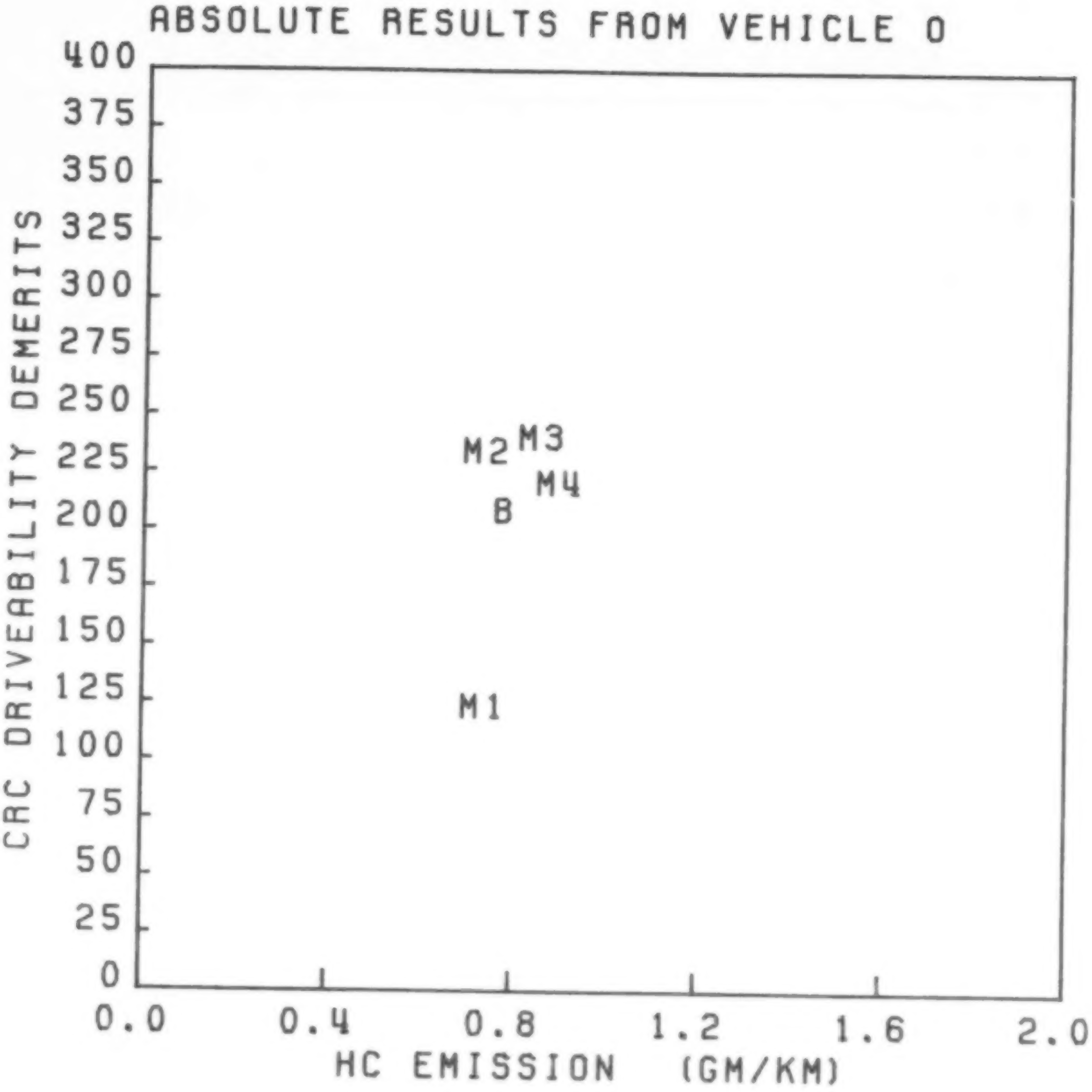

ABSOLUTE RESULTS FROM VEHICLE N
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)


ABSOLUTE RESULTS FROM VEHICLE N
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)

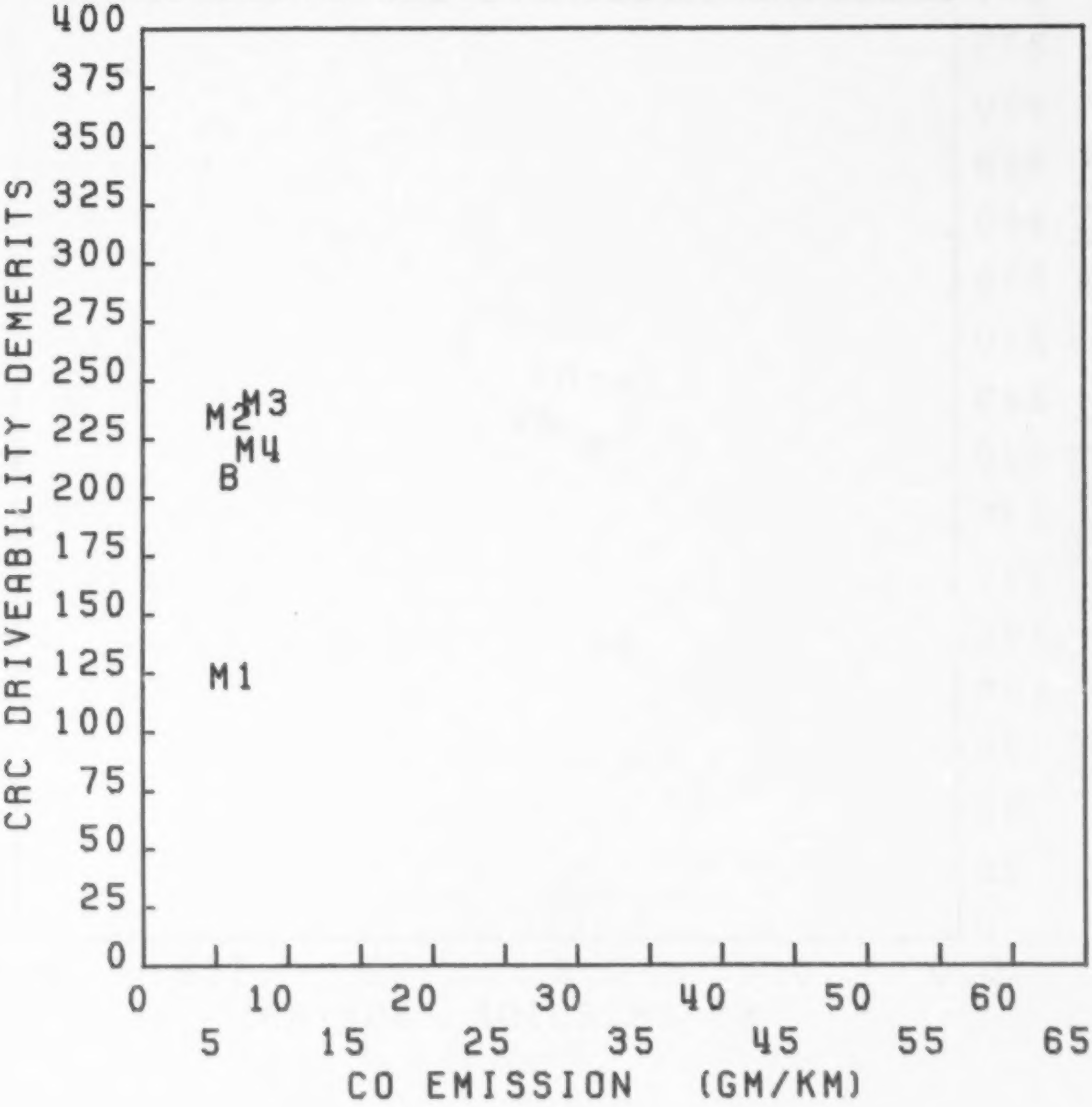

ABSOLUTE RESULTS FROM VEHICLE O
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M2
M4
B
M1
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)

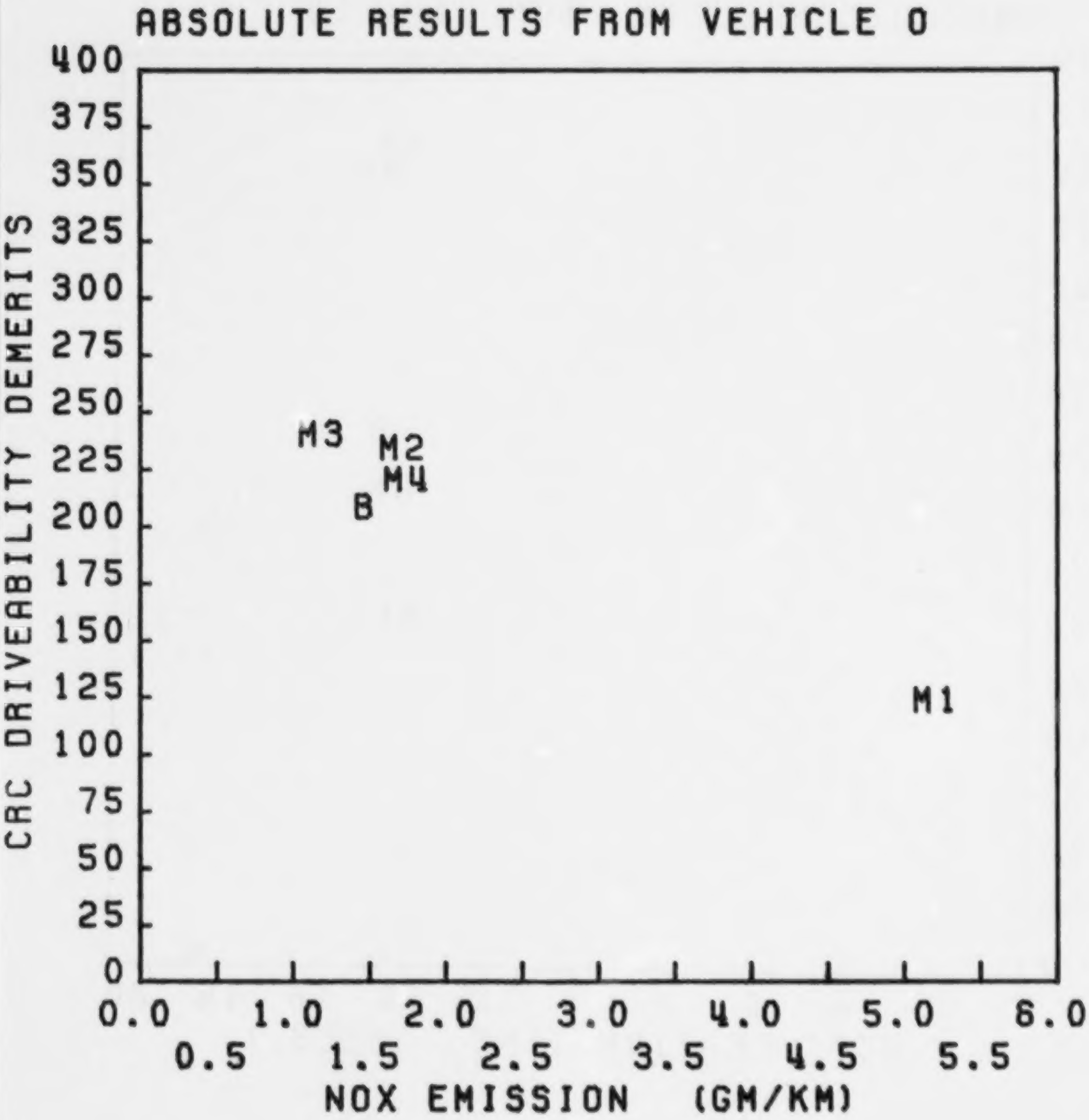

ABSOLUTE RESULTS FROM VEHICLE O
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M2
M4
B
M1
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)

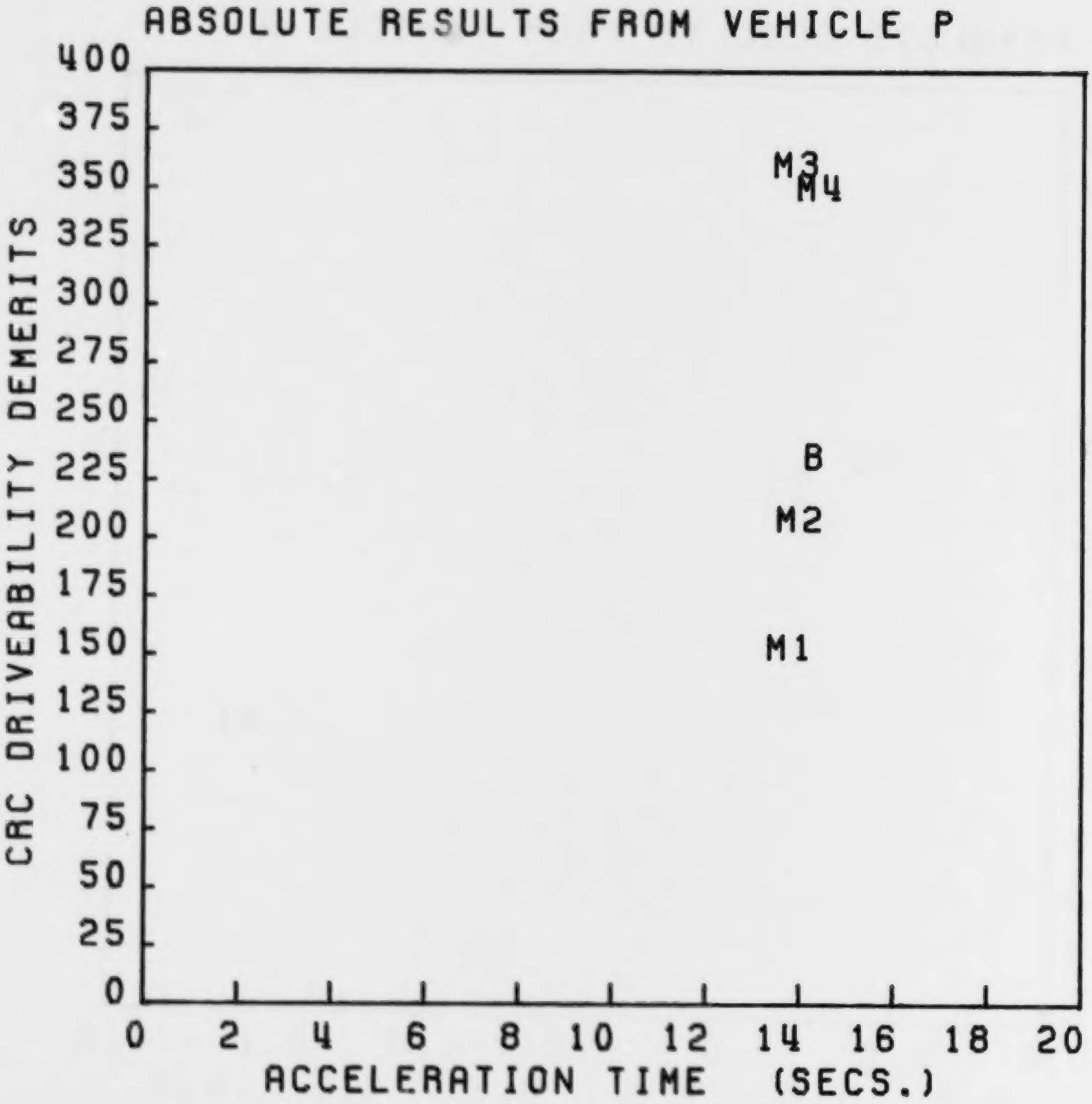

ABSOLUTE RESULTS FROM VEHICLE 0
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
HFET FUEL CONSUMPTION (L/1000KM)
M3
M2
M4
B
M1

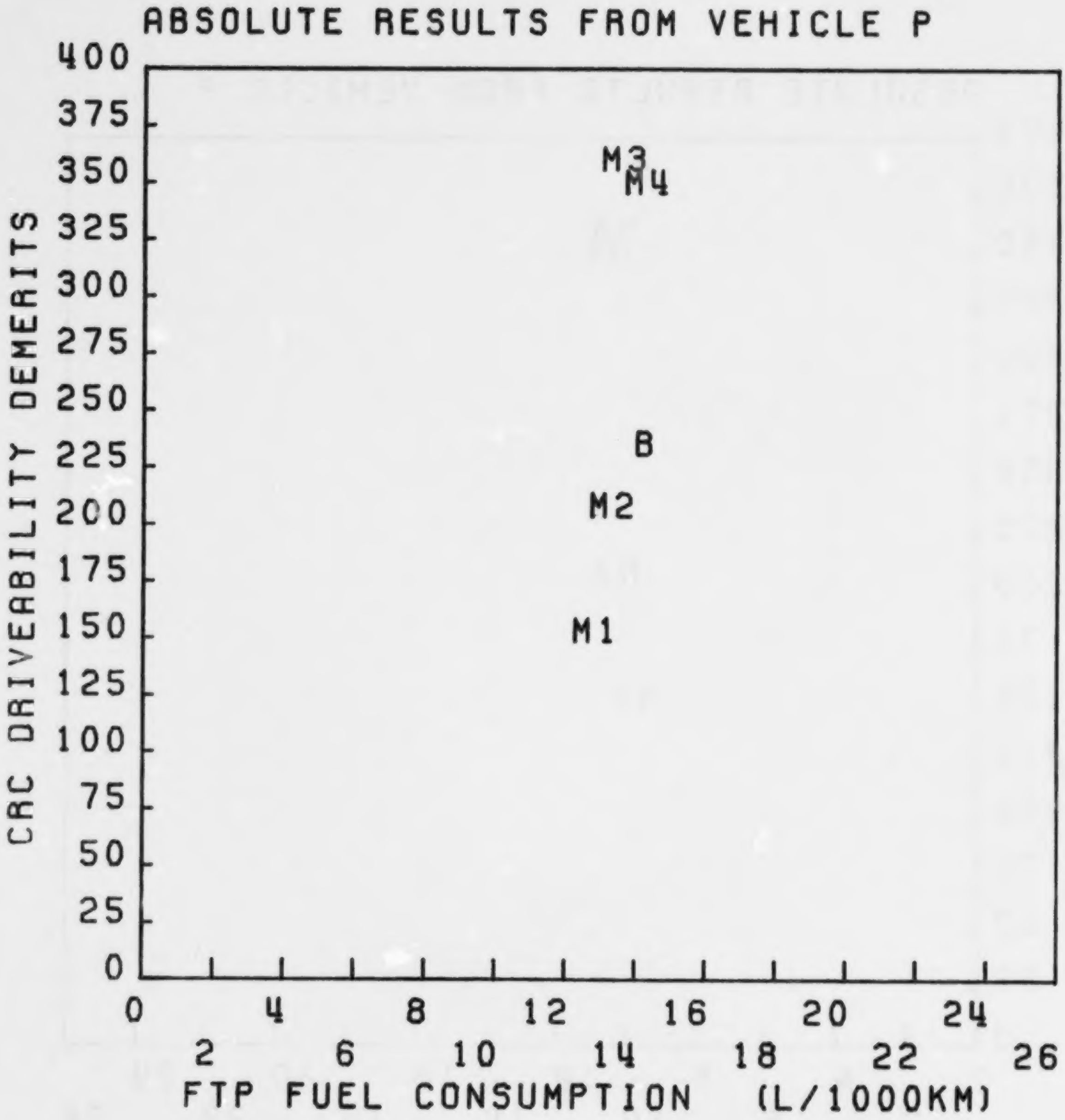

ABSOLUTE RESULTS FROM VEHICLE O
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M2
M3
M4
B
M1

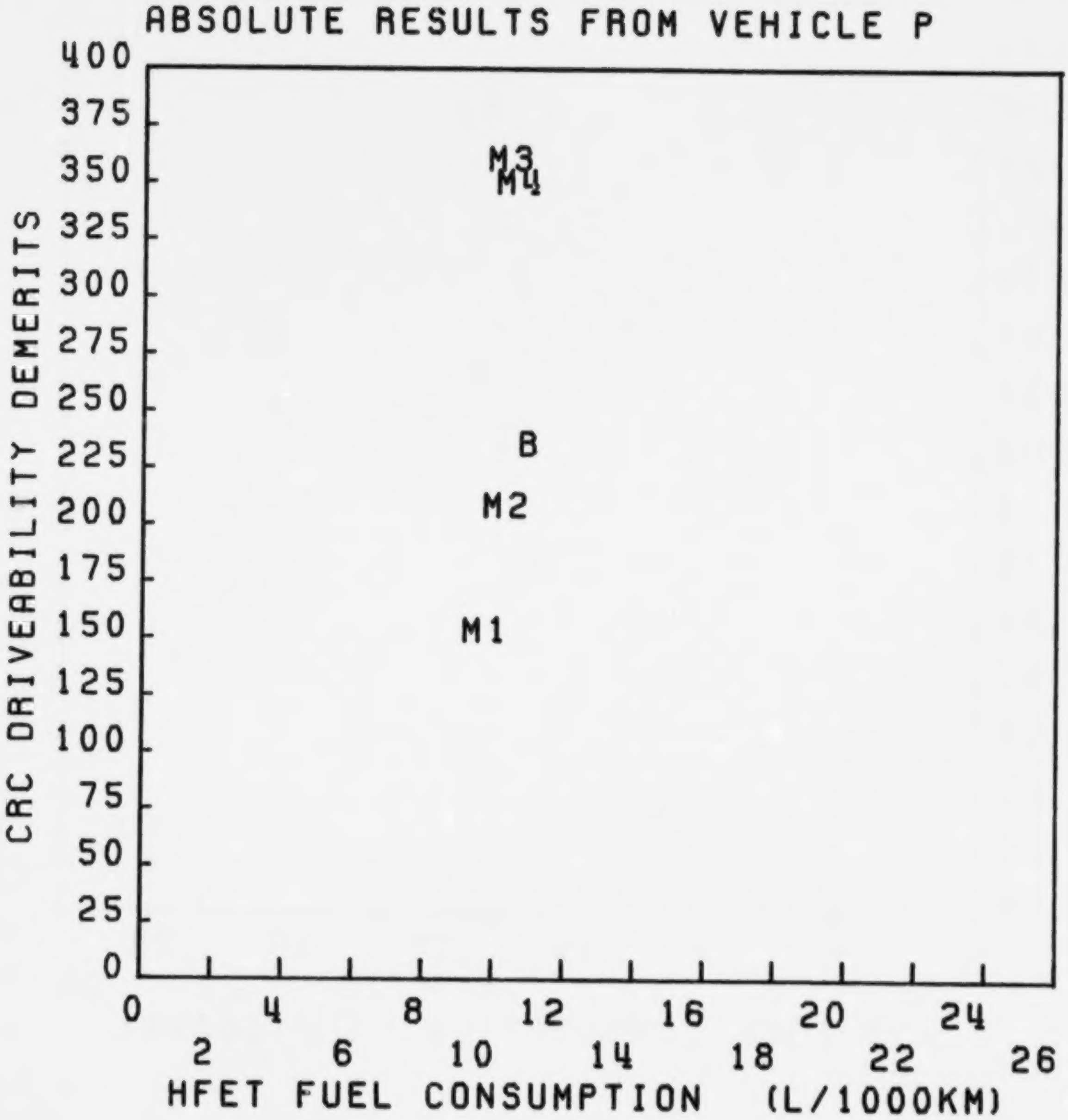
ABSOLUTE RESULTS FROM VEHICLE O

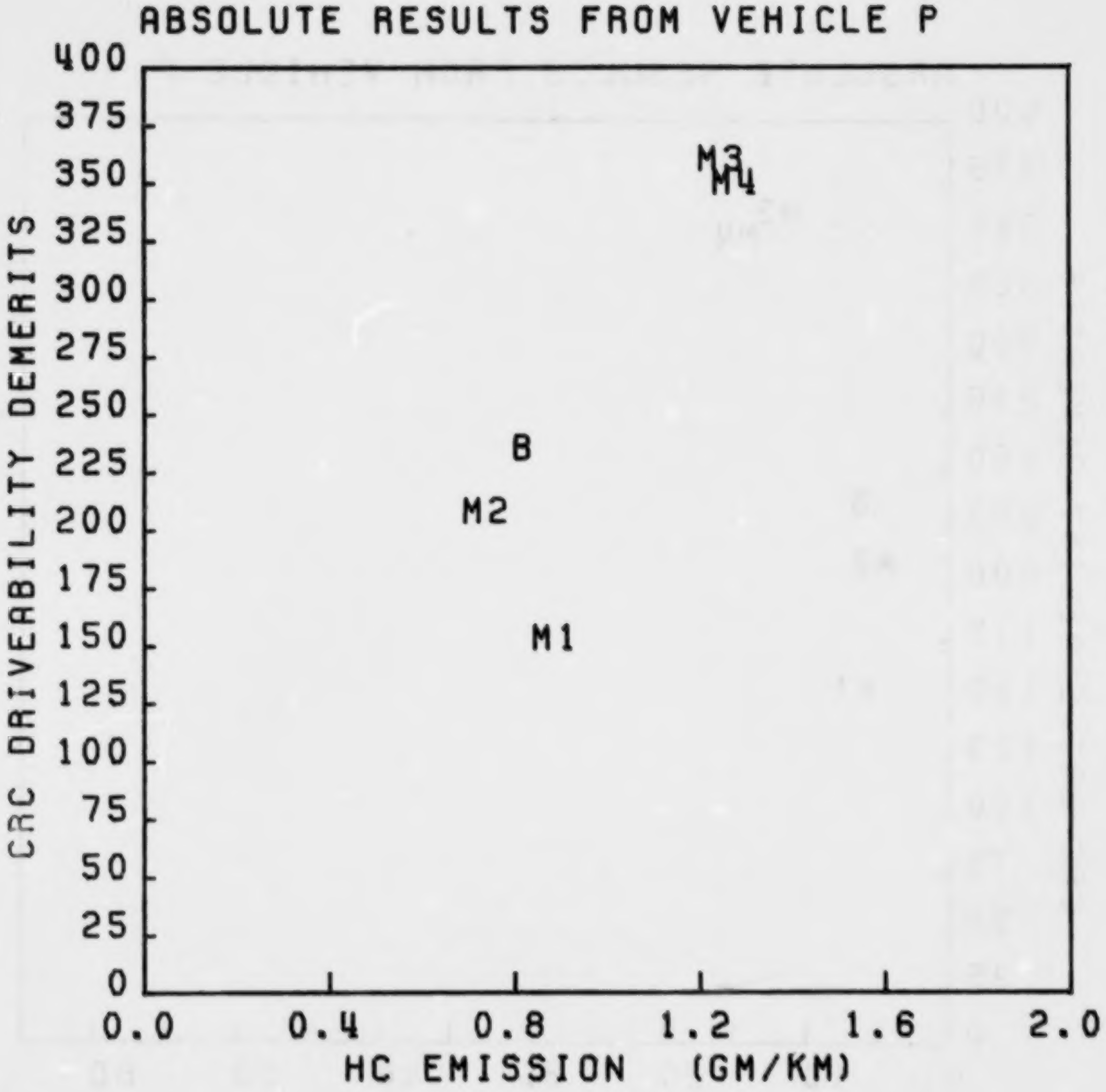


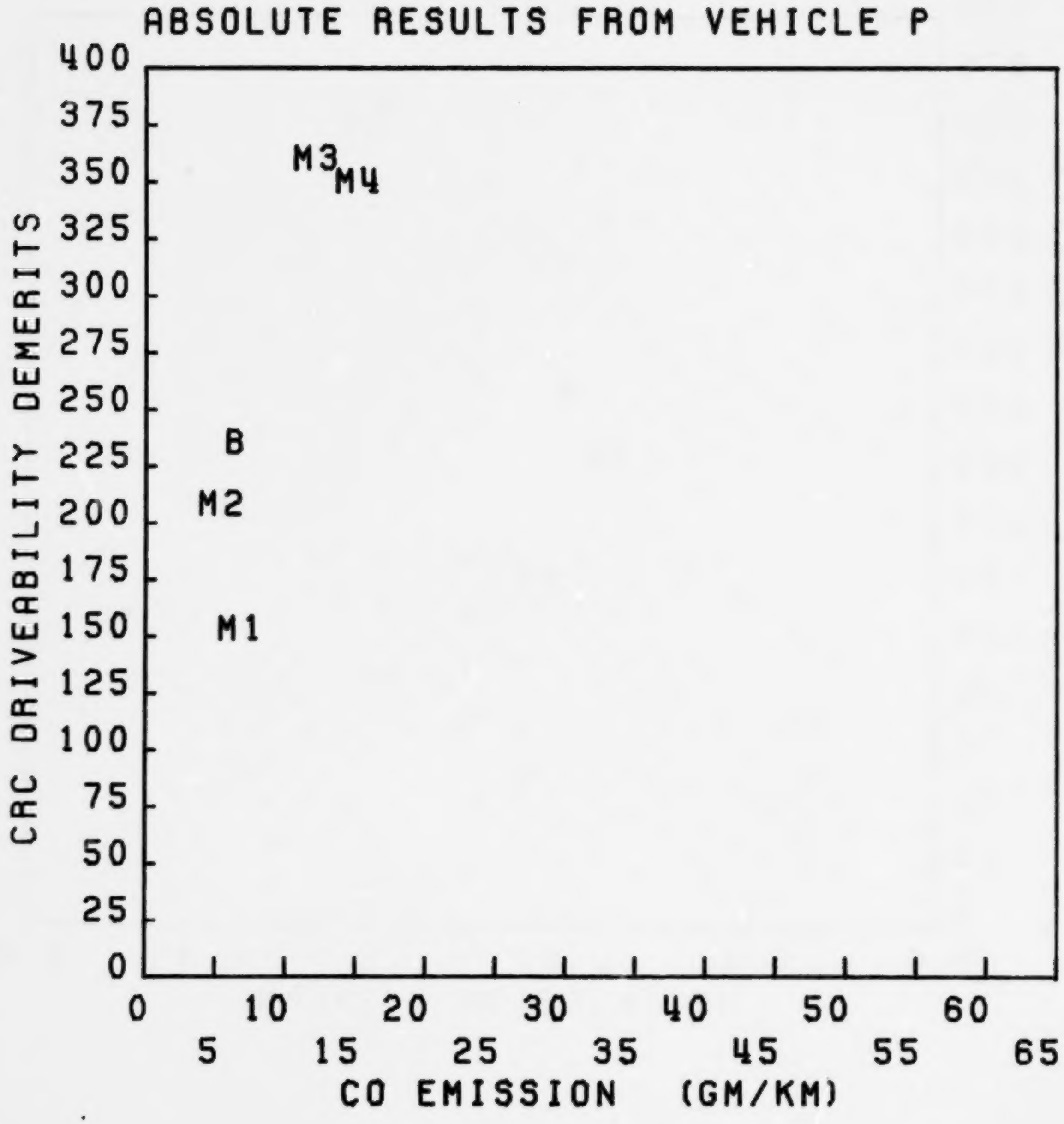

ABSOLUTE RESULTS FROM VEHICLE O
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)
M3
M2
M4
B
M1

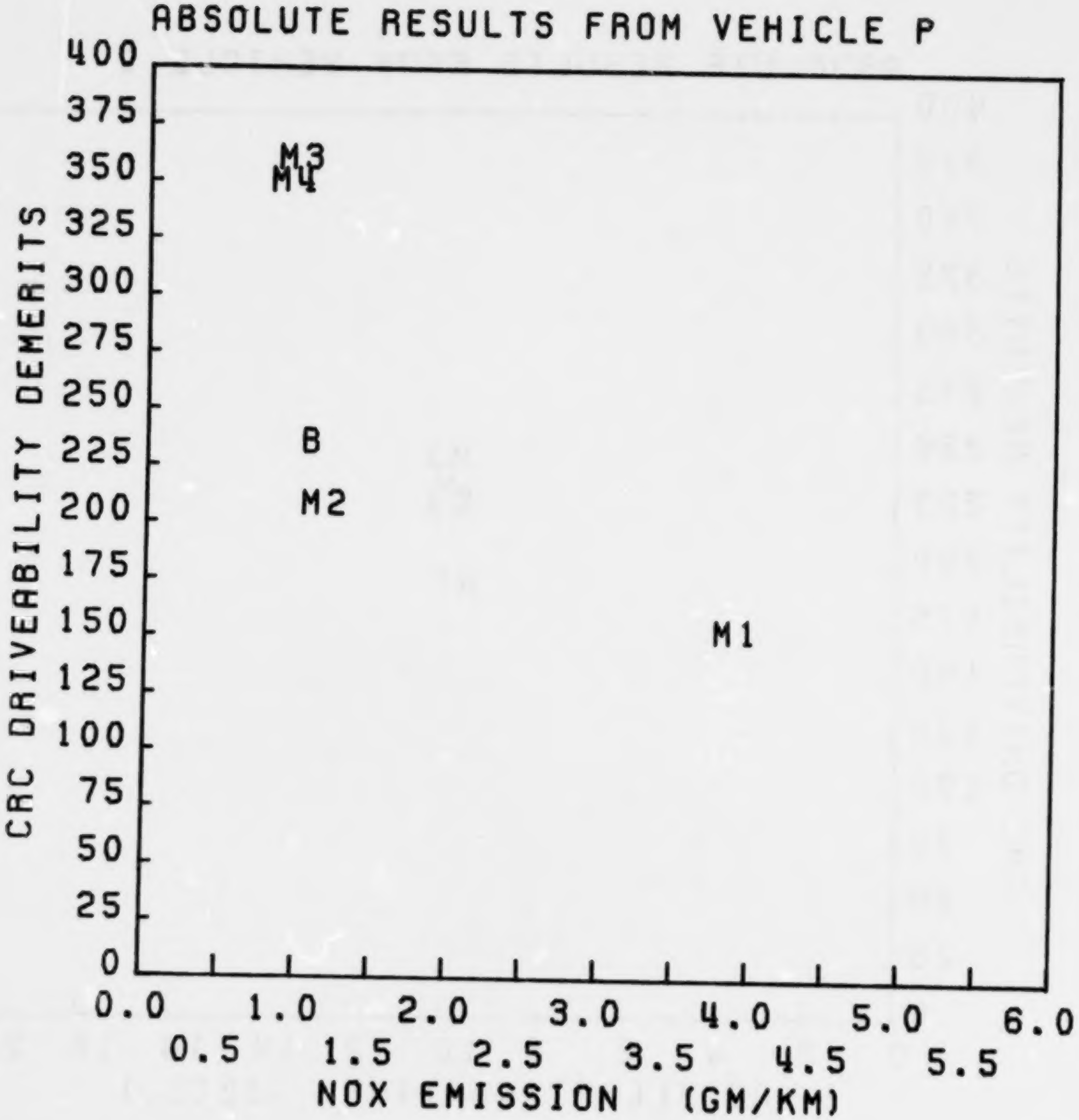

ABSOLUTE RESULTS FROM VEHICLE P
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M4
B
M2
M1
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)

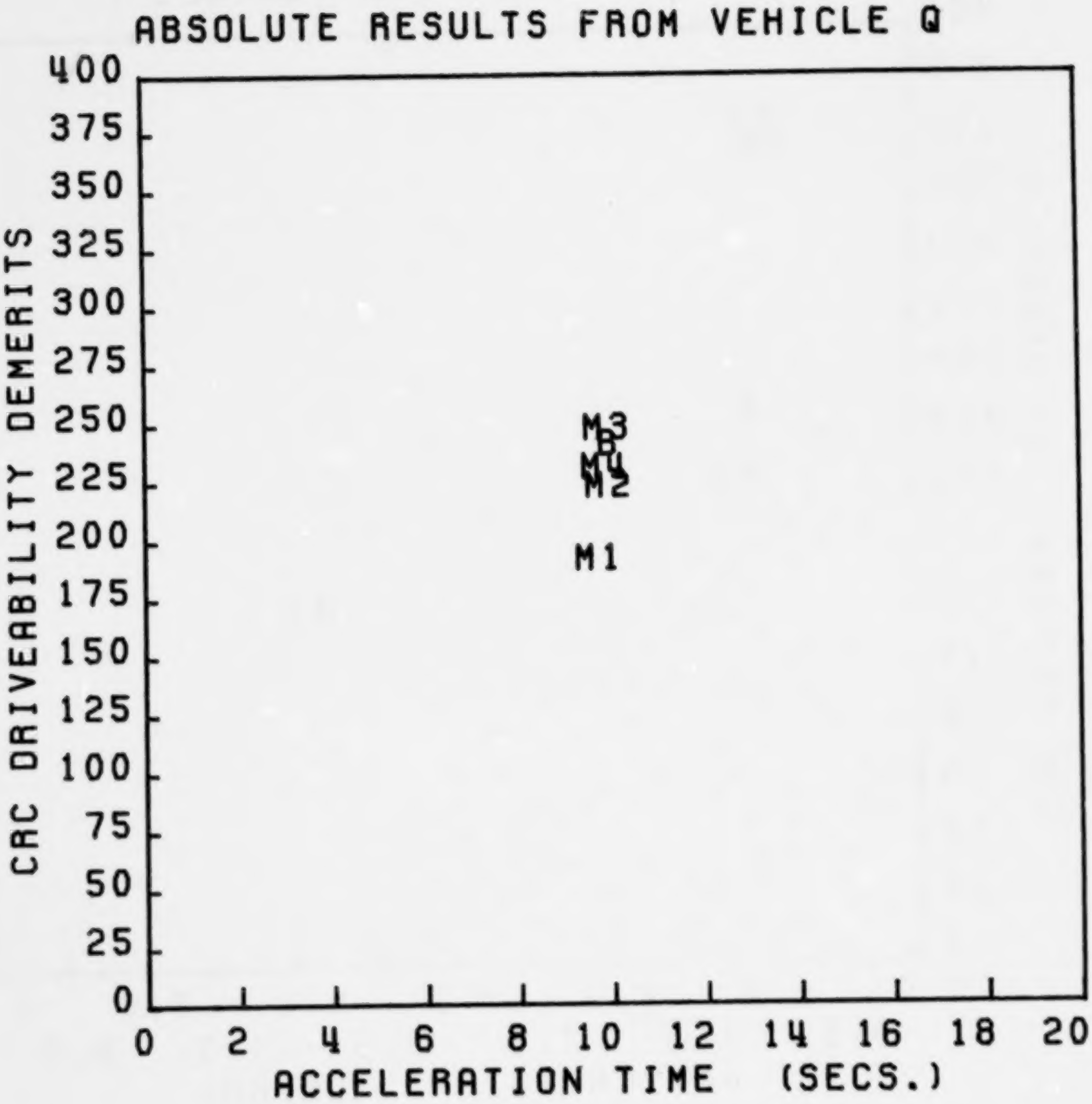

ABSOLUTE RESULTS FROM VEHICLE P
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M4
B
M2
M1
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)

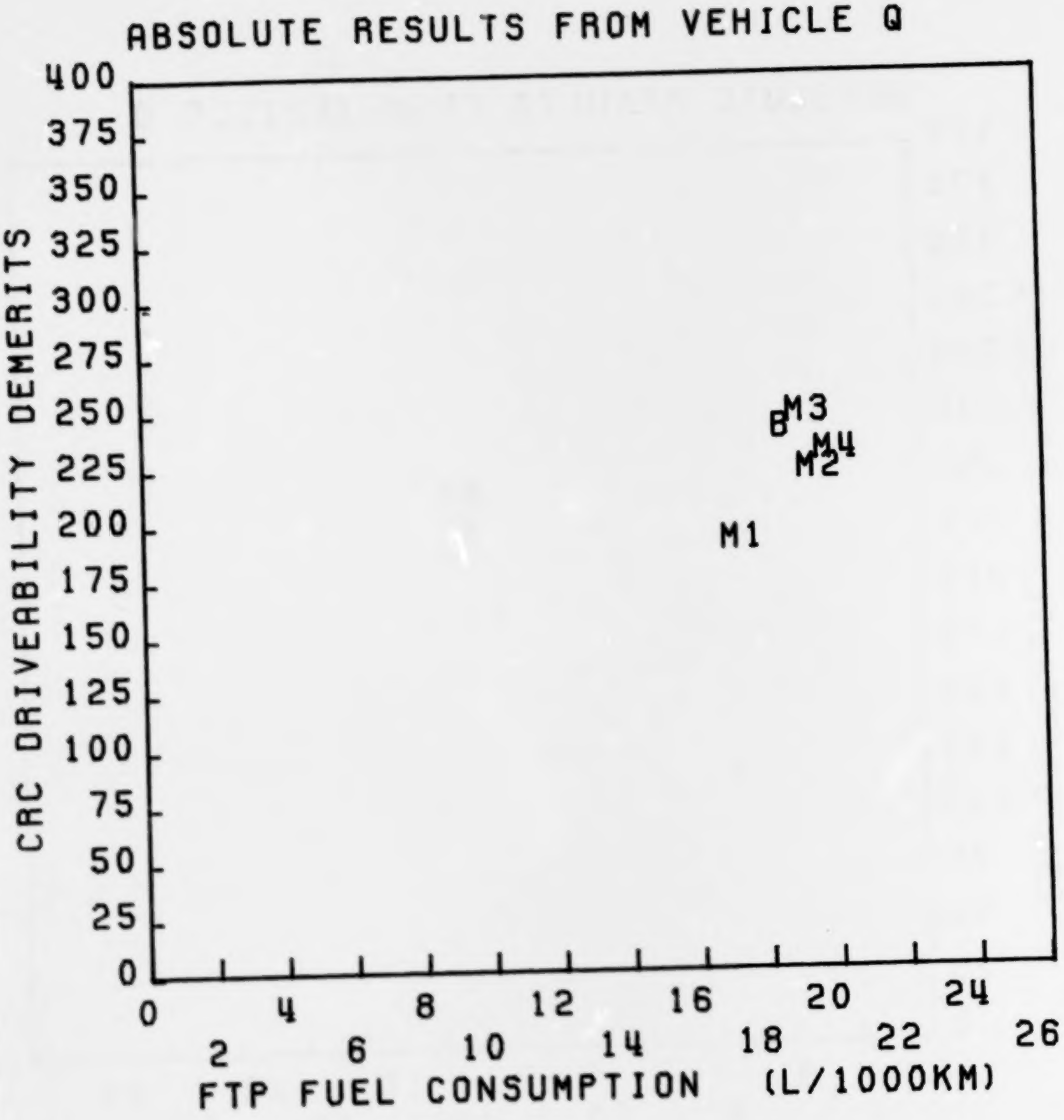
ABSOLUTE RESULTS FROM VEHICLE P
CRC DRIVEABILITY DEMERITS
HFET FUEL CONSUMPTION (L/1000KM)
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
M3
M4
B
M2
M1

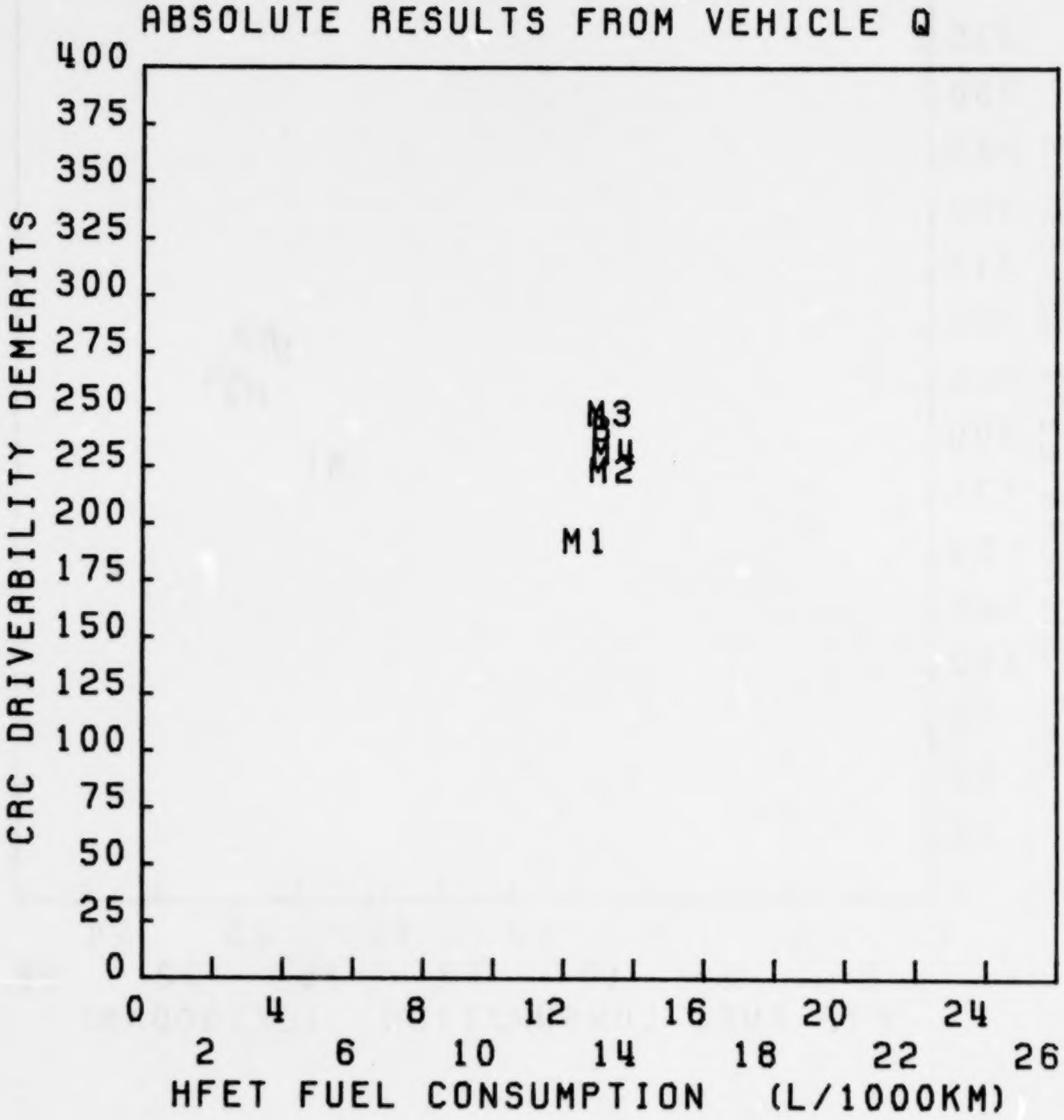

ABSOLUTE RESULTS FROM VEHICLE P
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M3
M4
B
M2
M1

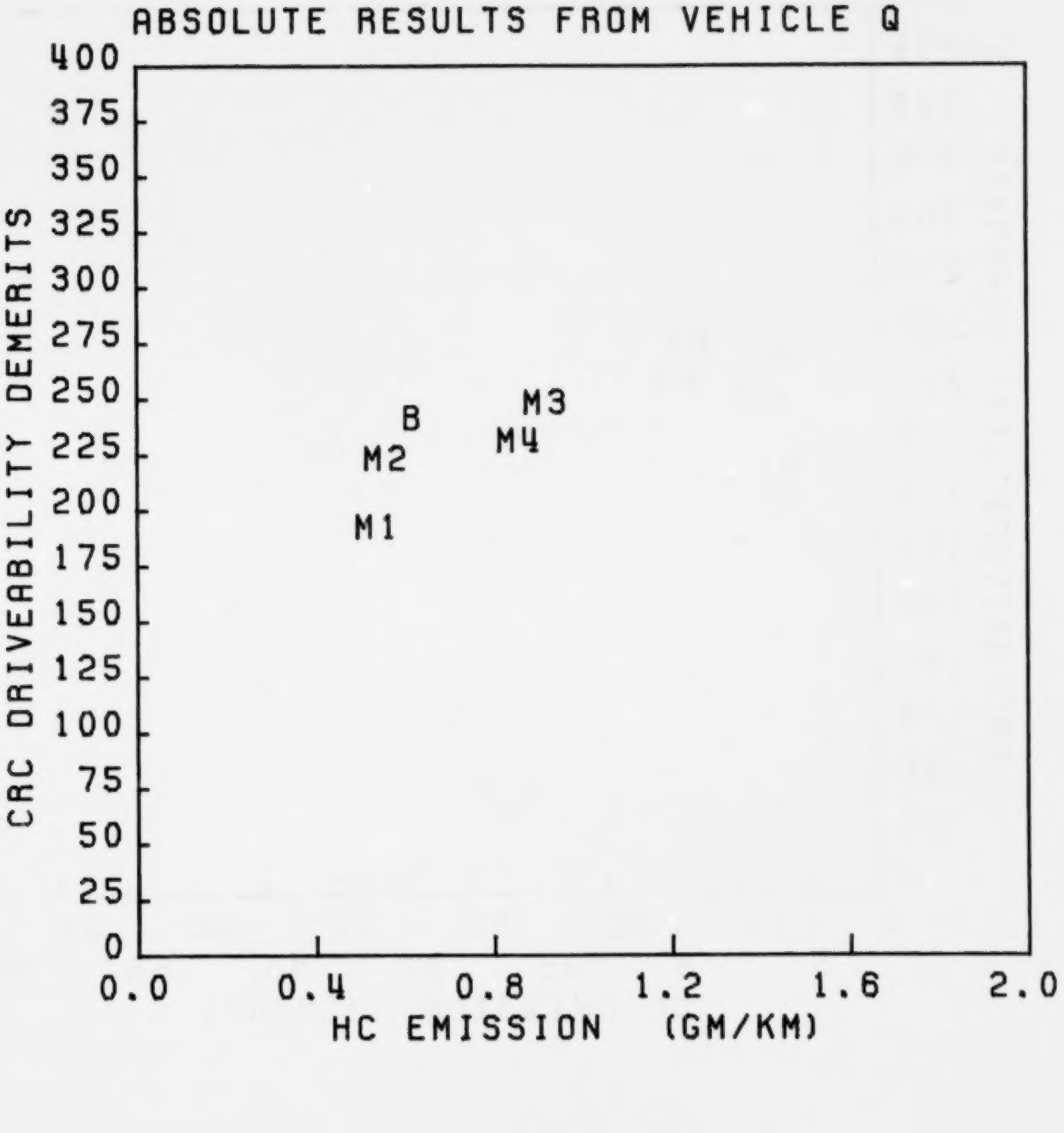

ABSOLUTE RESULTS FROM VEHICLE P
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M4
B
M2
M1
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

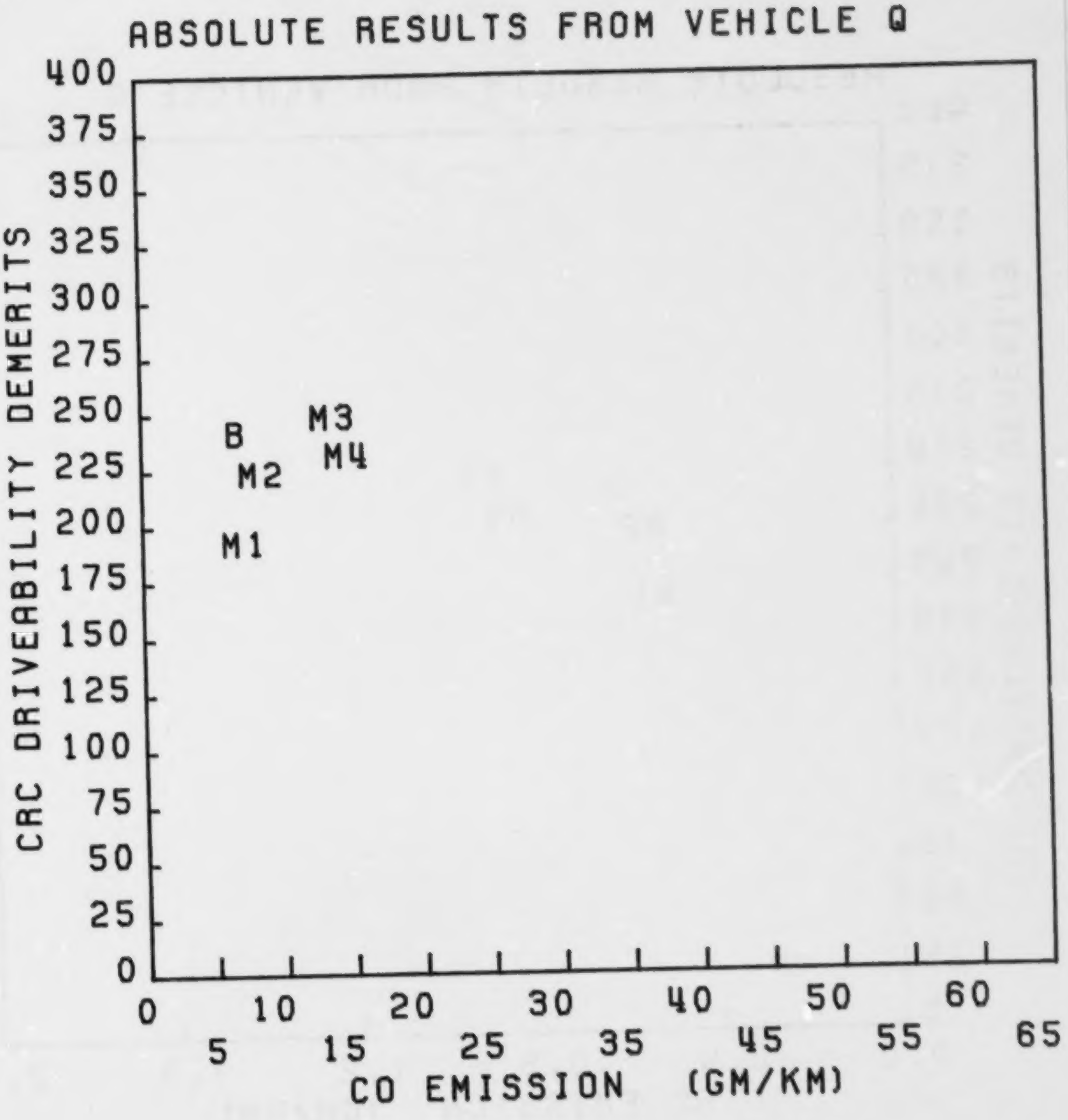

ABSOLUTE RESULTS FROM VEHICLE P
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
NOX EMISSION (GM/KM)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
M3
M4
B
M2
M1


ABSOLUTE RESULTS FROM VEHICLE Q
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)
M3
B
M4
M2
M1

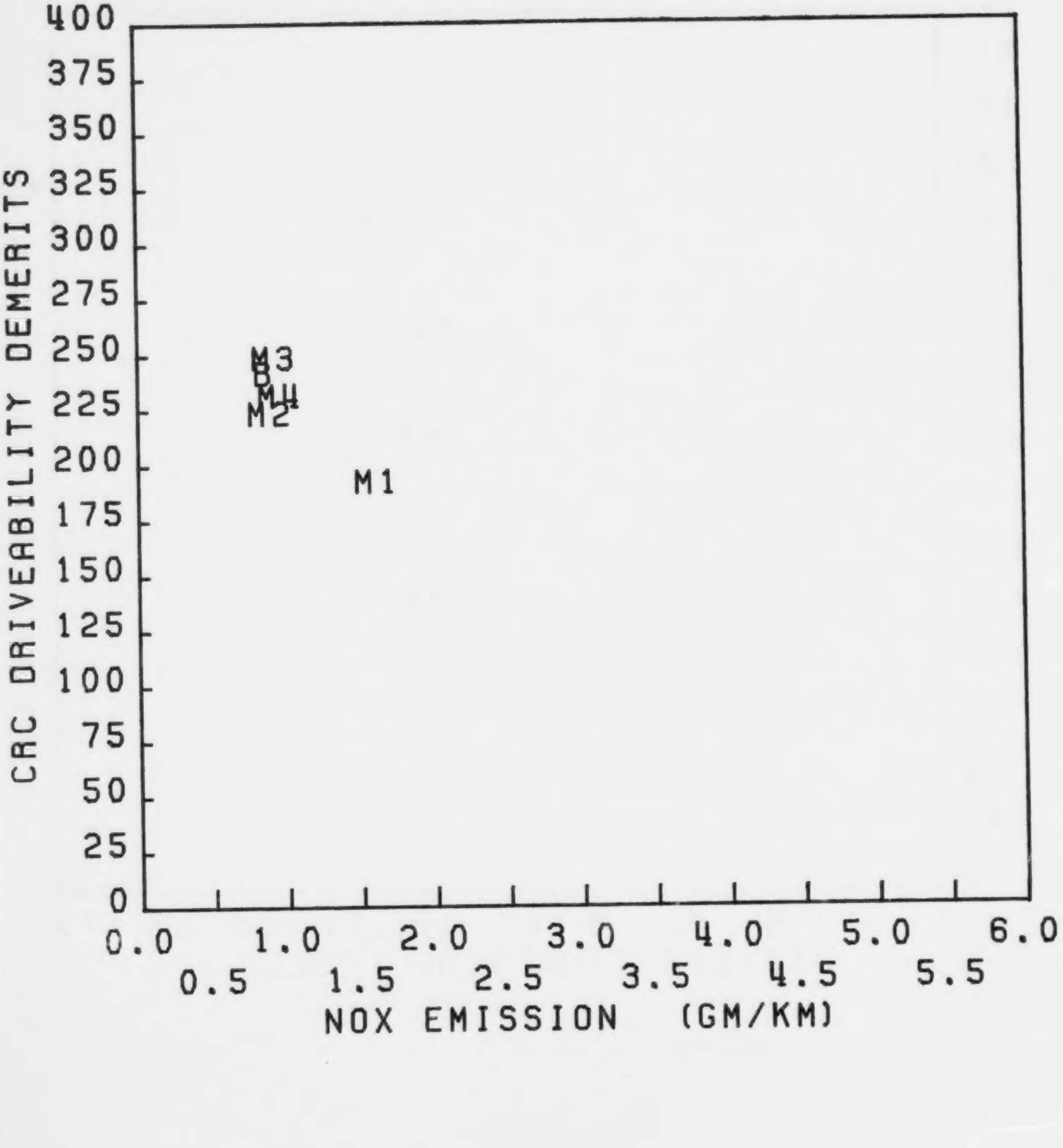

ABSOLUTE RESULTS FROM VEHICLE Q
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)
B
M1
M2
M3
M4

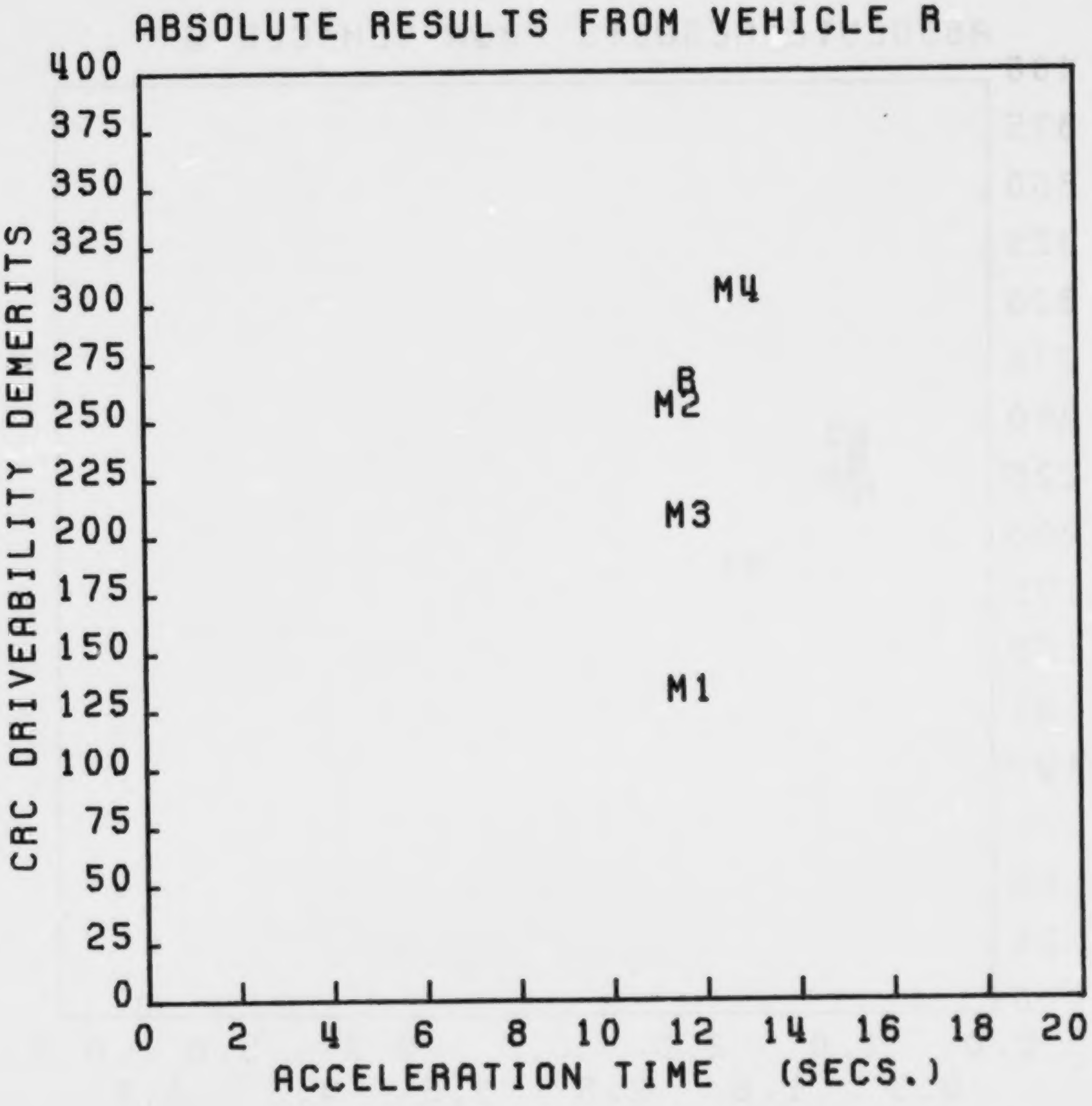

ABSOLUTE RESULTS FROM VEHICLE Q
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
HFET FUEL CONSUMPTION (L/1000KM)
0
4
8
12
16
20
24
2
6
10
14
18
22
26
M3
B
M4
M2
M1

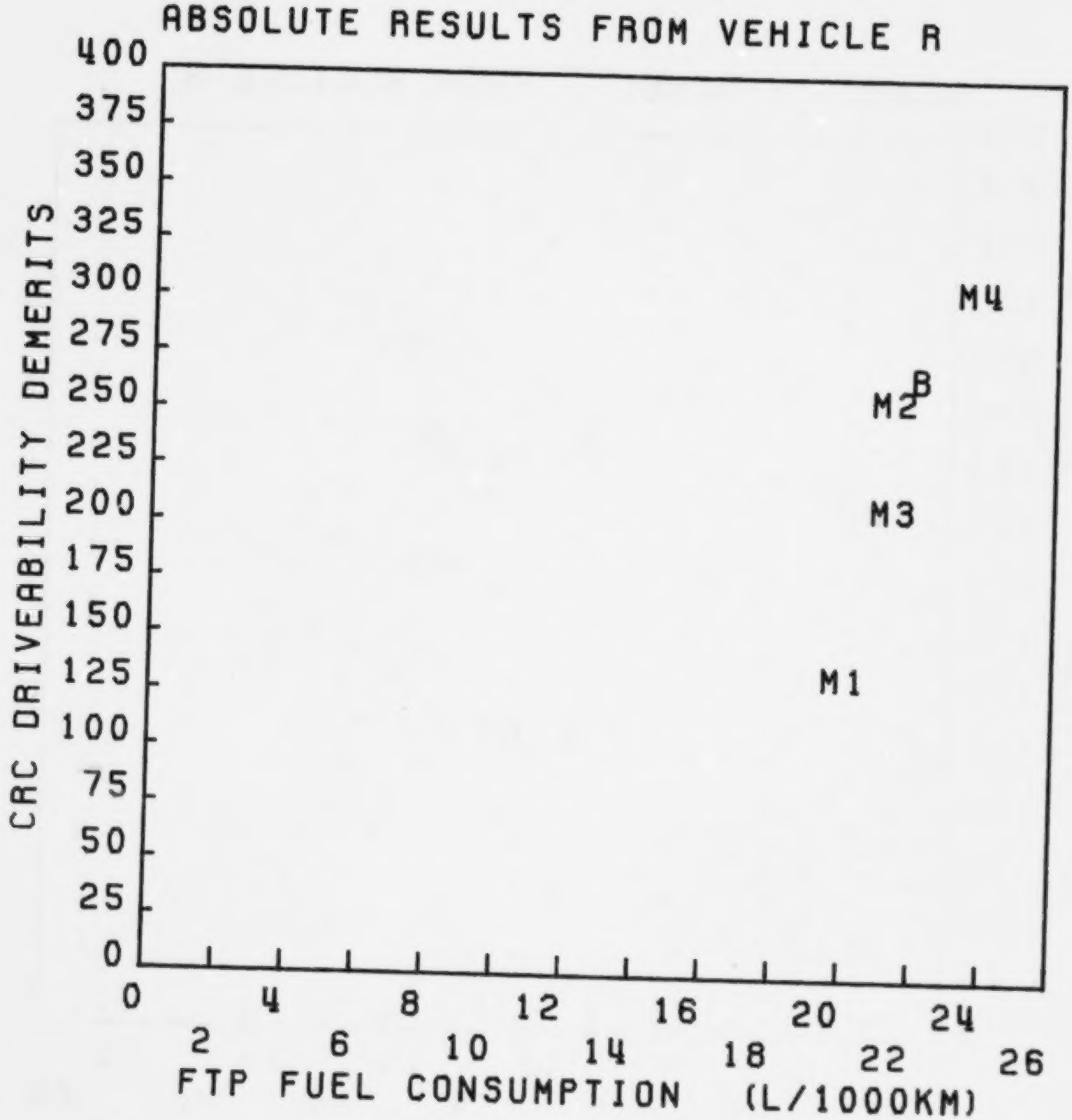

ABSOLUTE RESULTS FROM VEHICLE Q
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
B
M1
M2
M3
M4

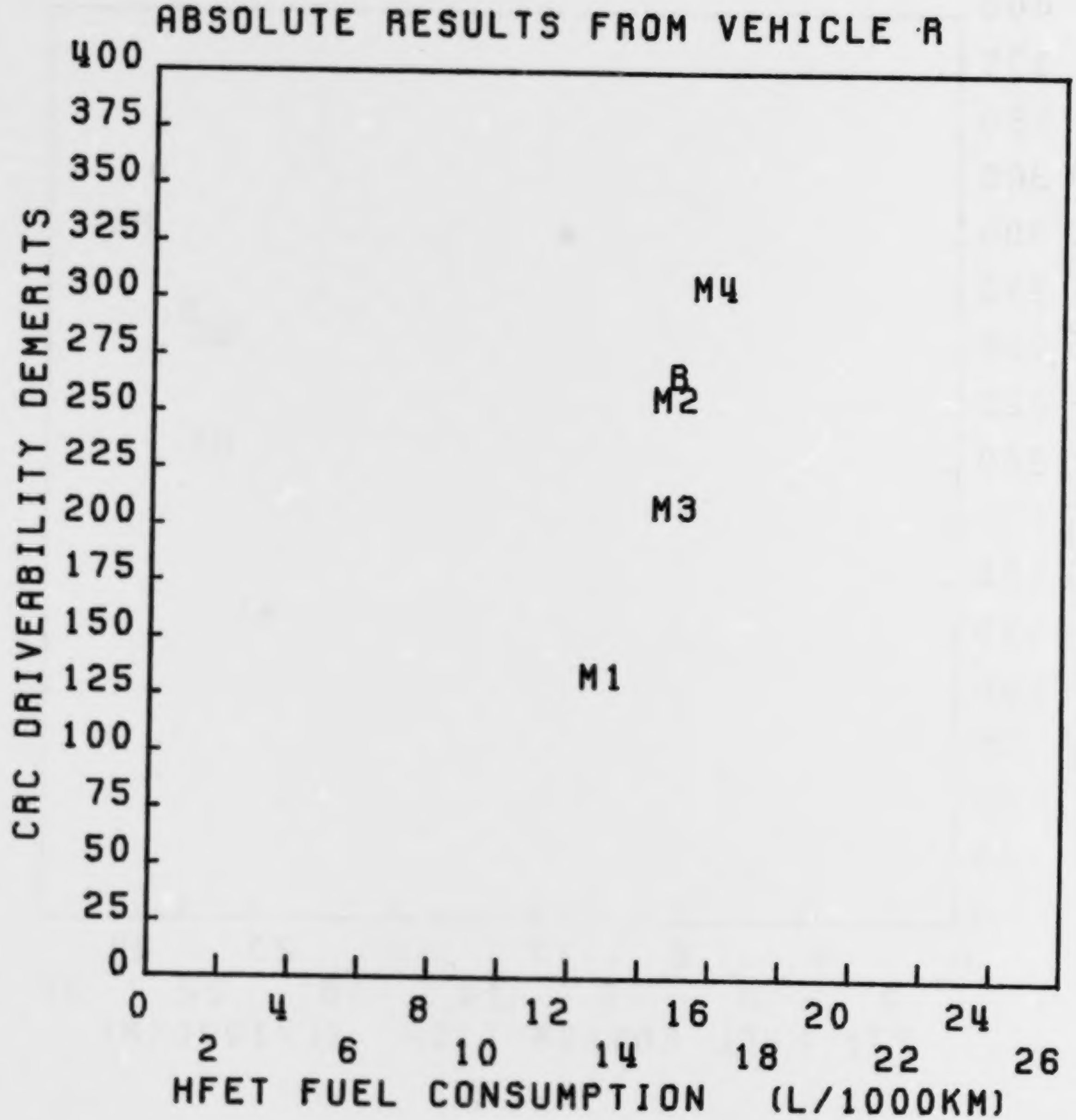

ABSOLUTE RESULTS FROM VEHICLE Q
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
B
M2
M1
M3
M4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

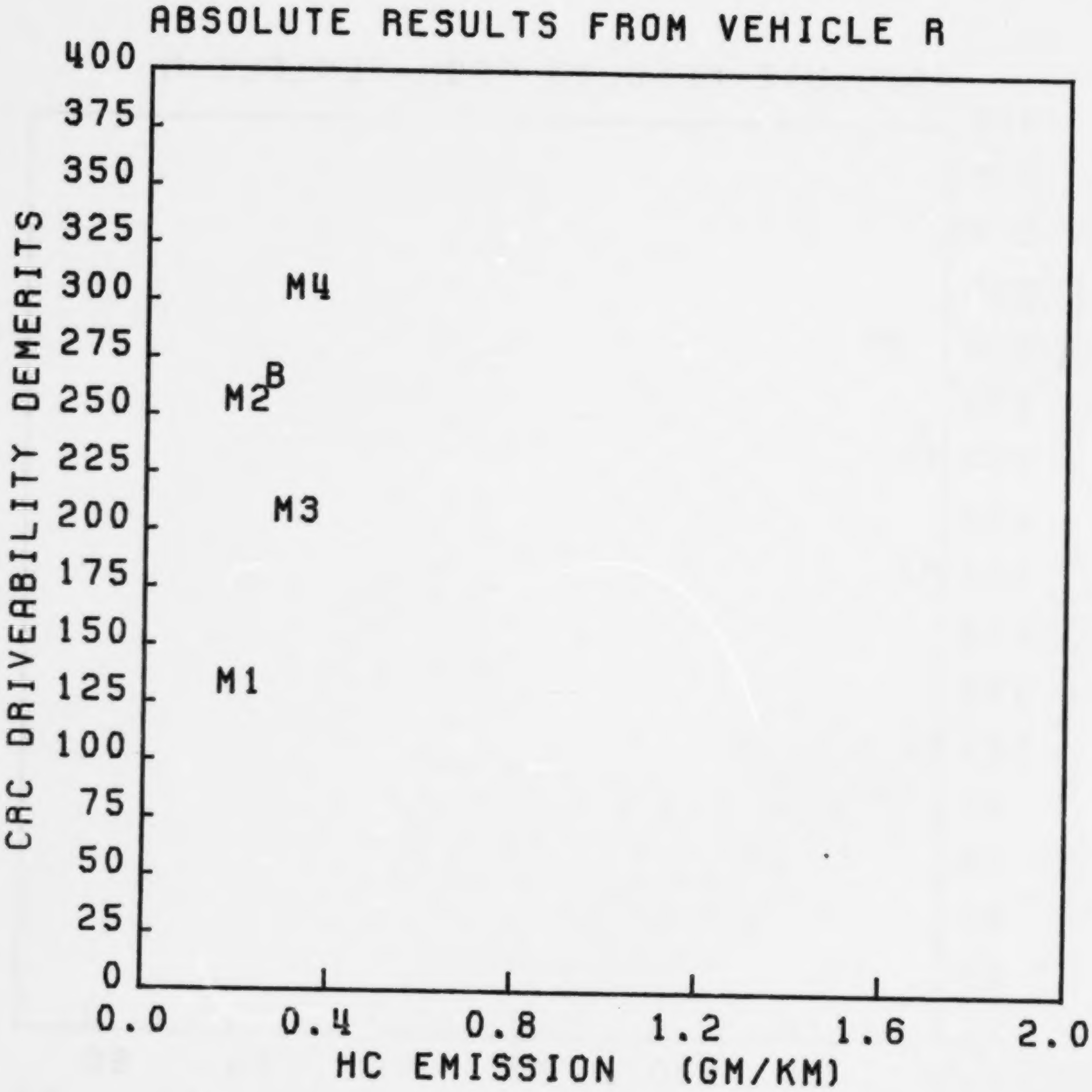
ABSOLUTE RESULTS FROM VEHICLE Q

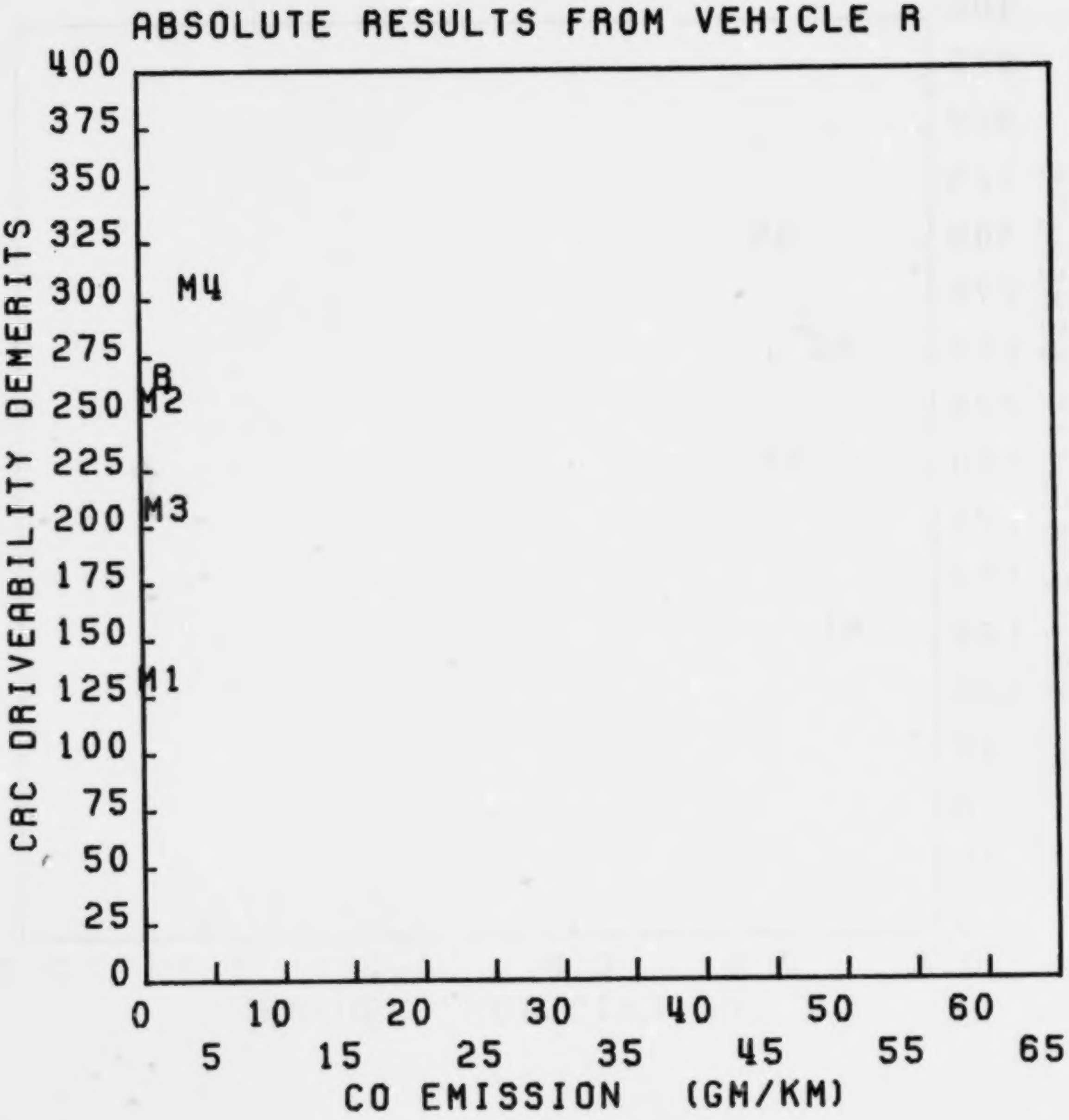


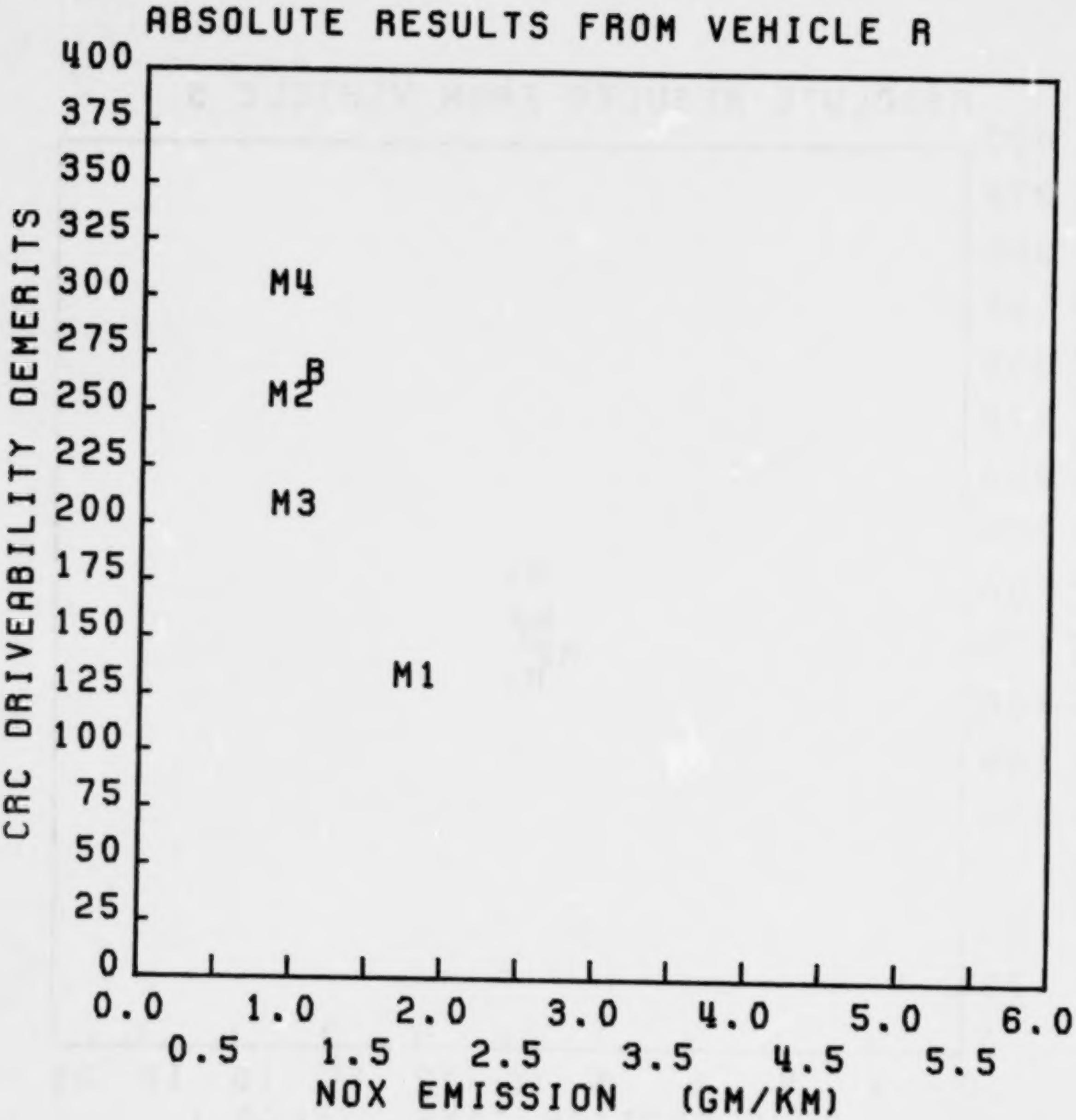

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)
M4
B
M2
M3
M1

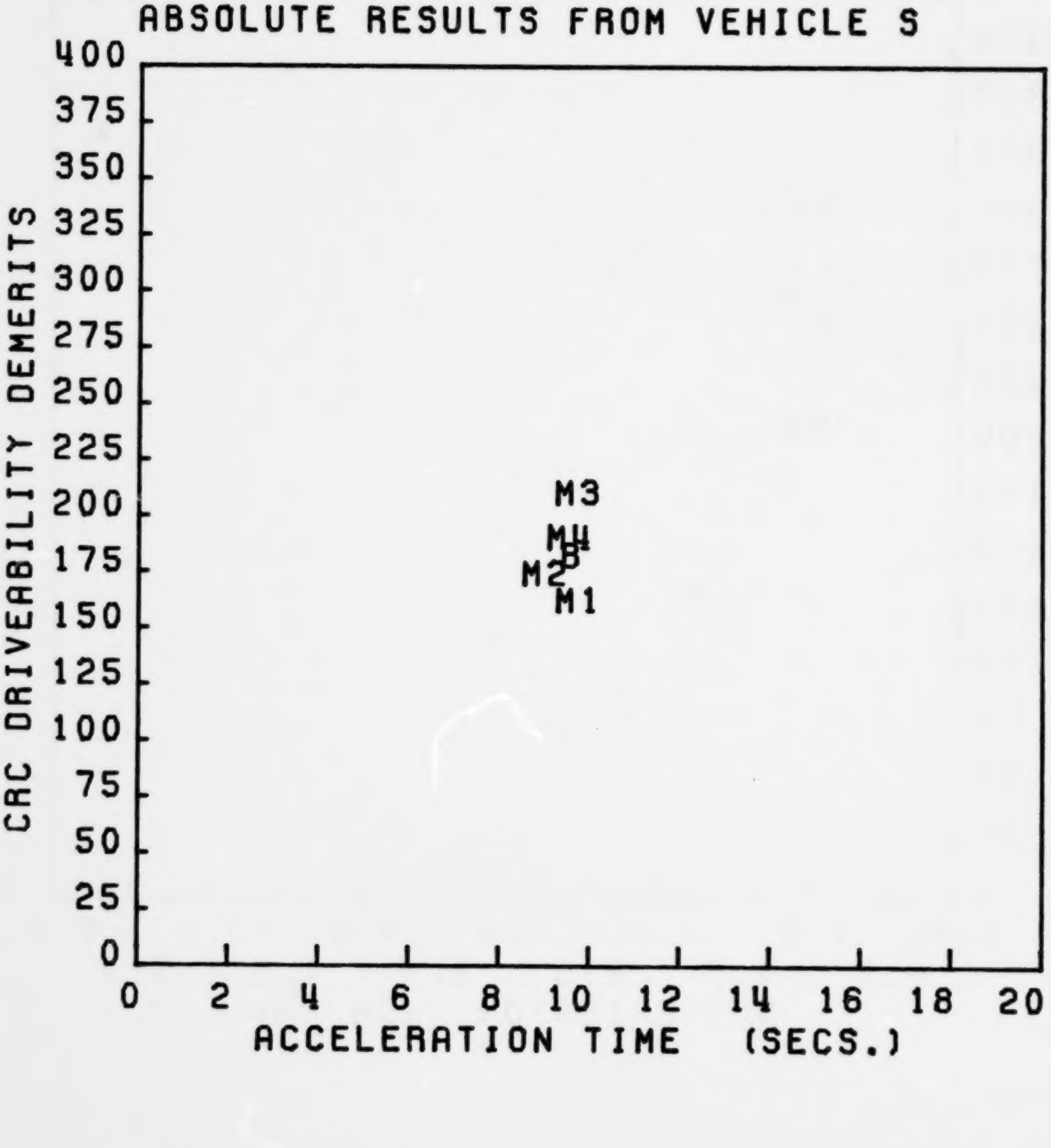
ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M2
M3
M1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)

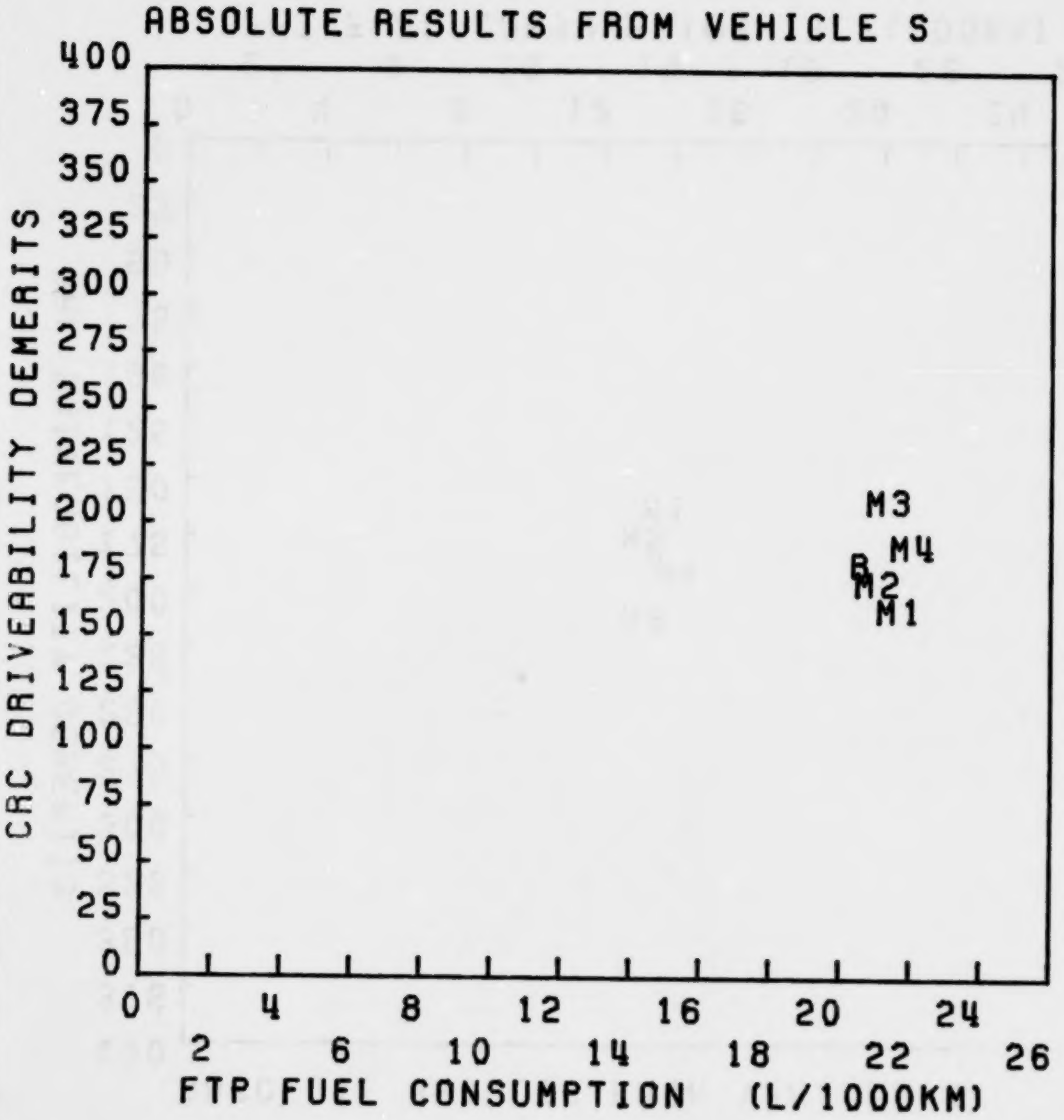

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M2
M3
M1
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

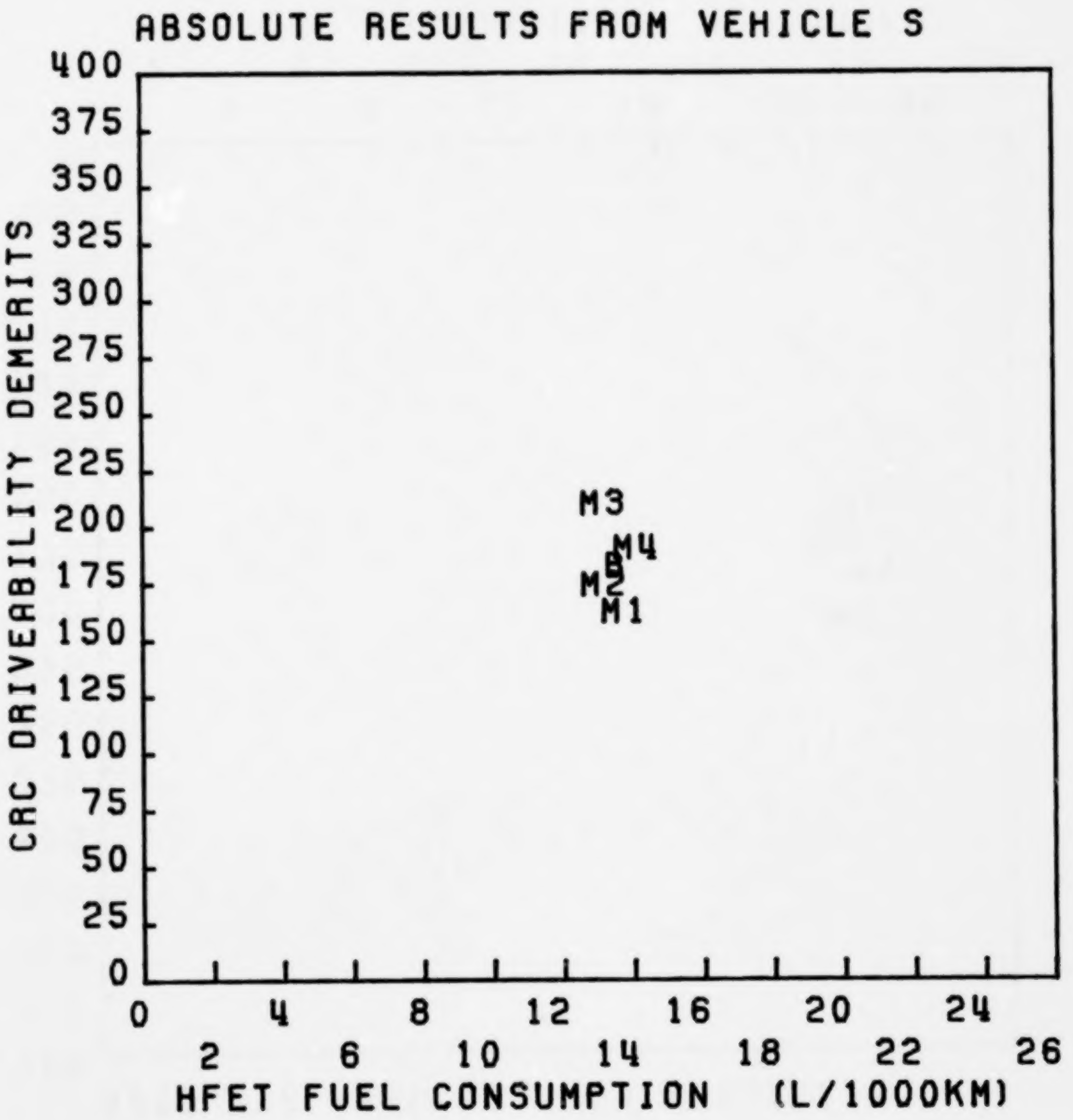

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
HC EMISSION (GM/KM)
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
M4
B
M2
M3
M1

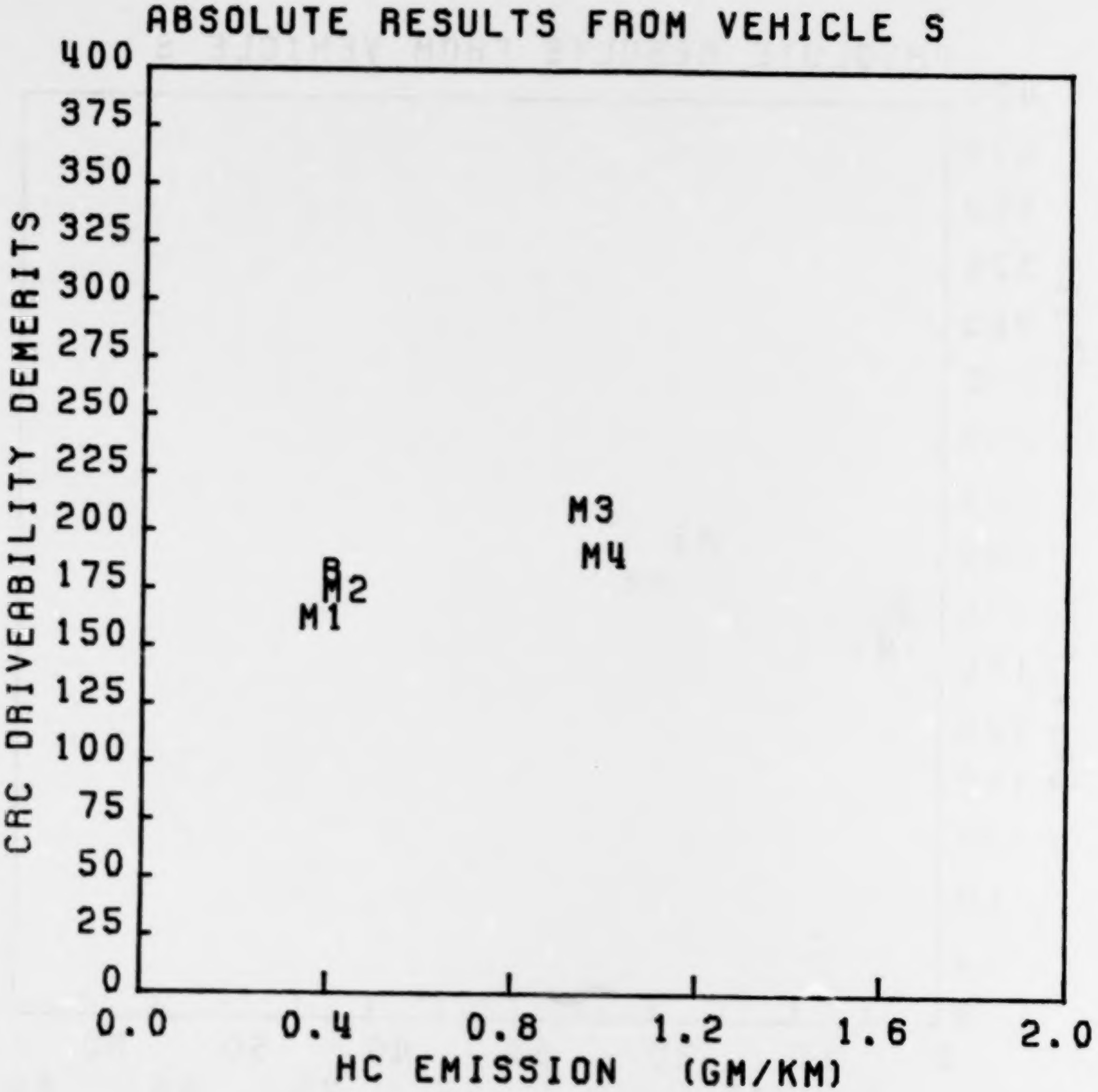

ABSOLUTE RESULTS FROM VEHICLE R
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M2
M3
M1
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

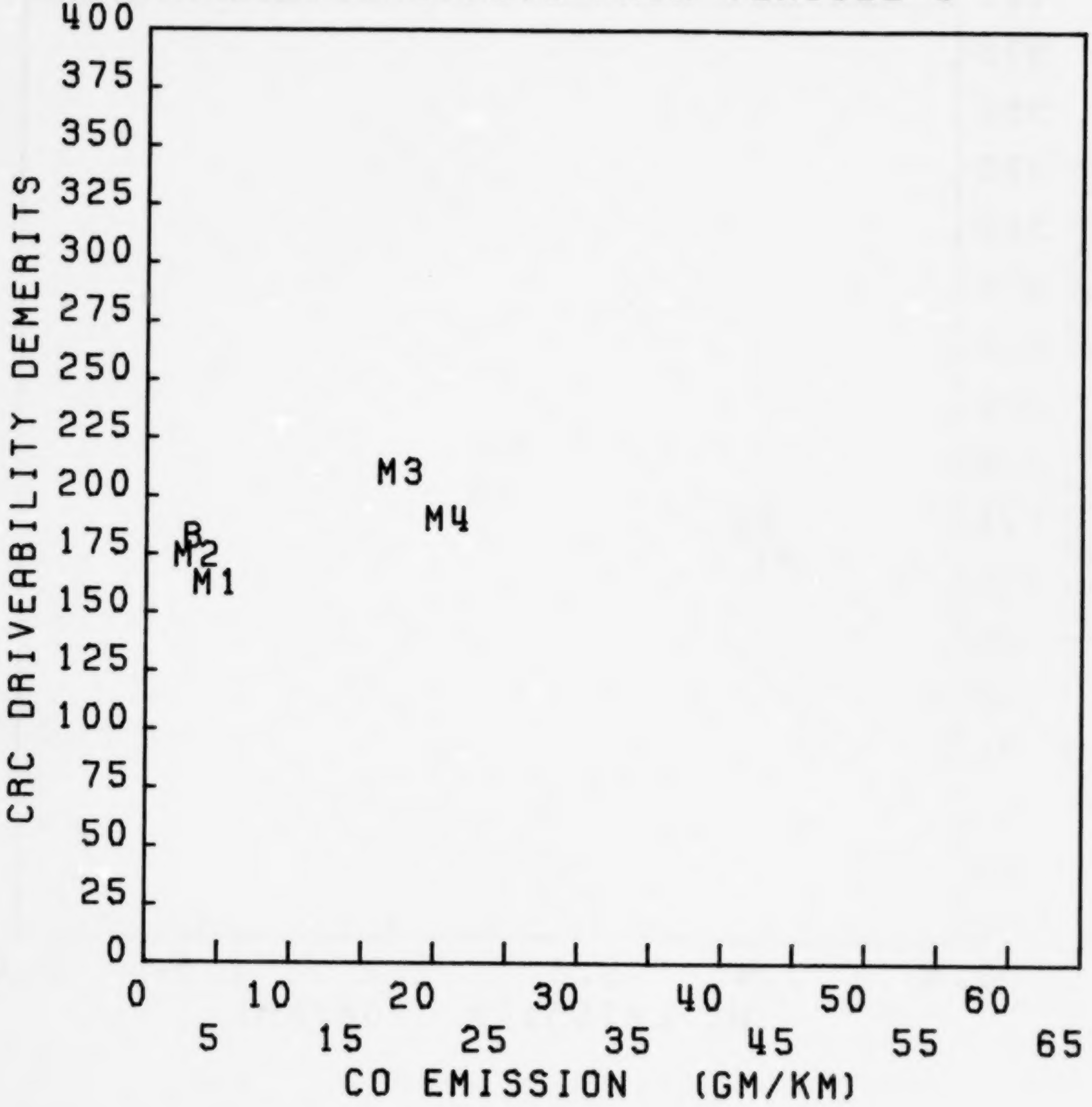

ABSOLUTE RESULTS FROM VEHICLE A
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M4
B
M2
M3
M1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)


ABSOLUTE RESULTS FROM VEHICLE S
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
ACCELERATION TIME (SECS.)
0
2
4
6
8
10
12
14
16
18
20
M3
M4
B
M2
M1

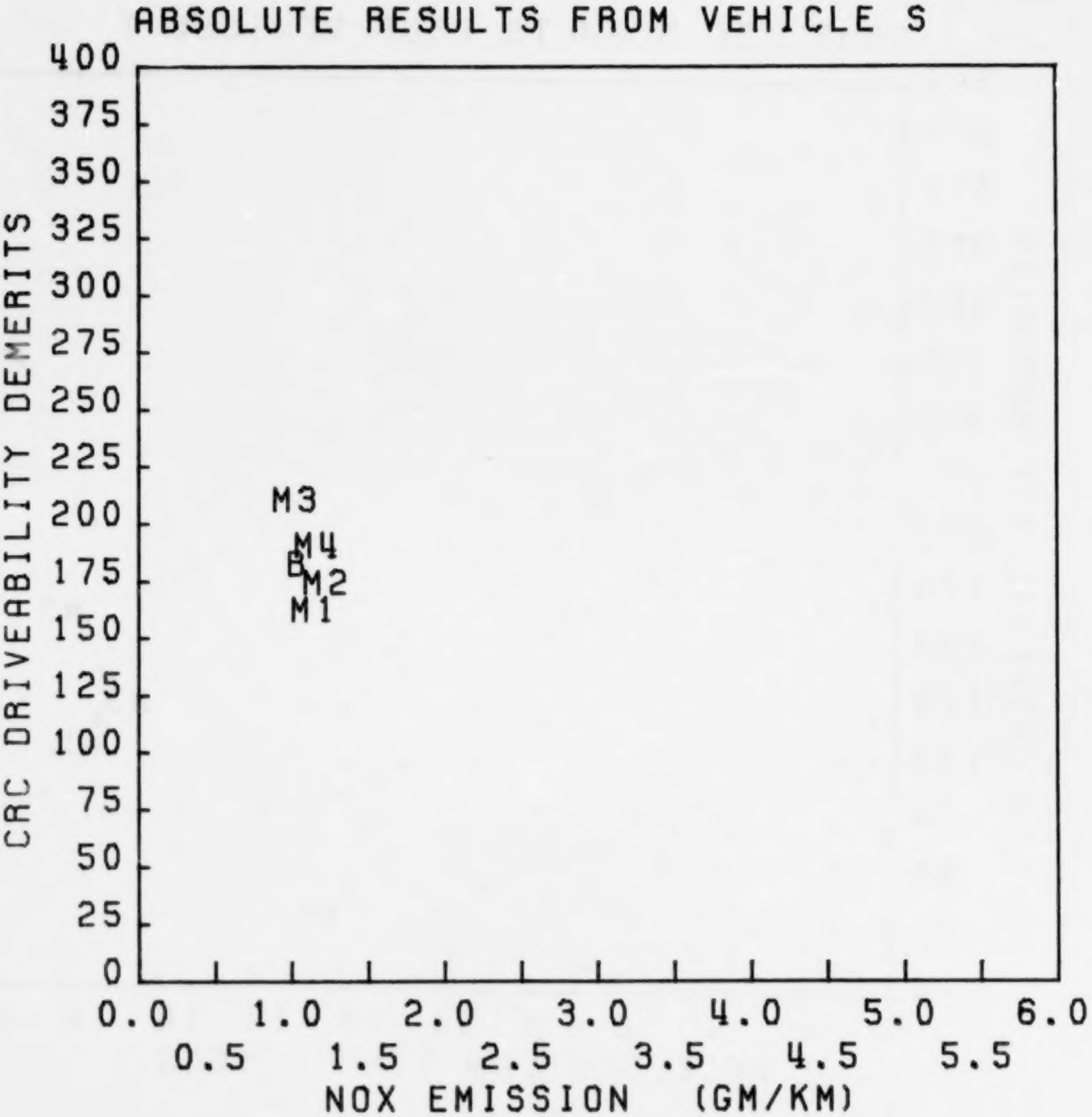

ABSOLUTE RESULTS FROM VEHICLE S
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
FTP FUEL CONSUMPTION (L/1000KM)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
M3
M4
B
M2
M1

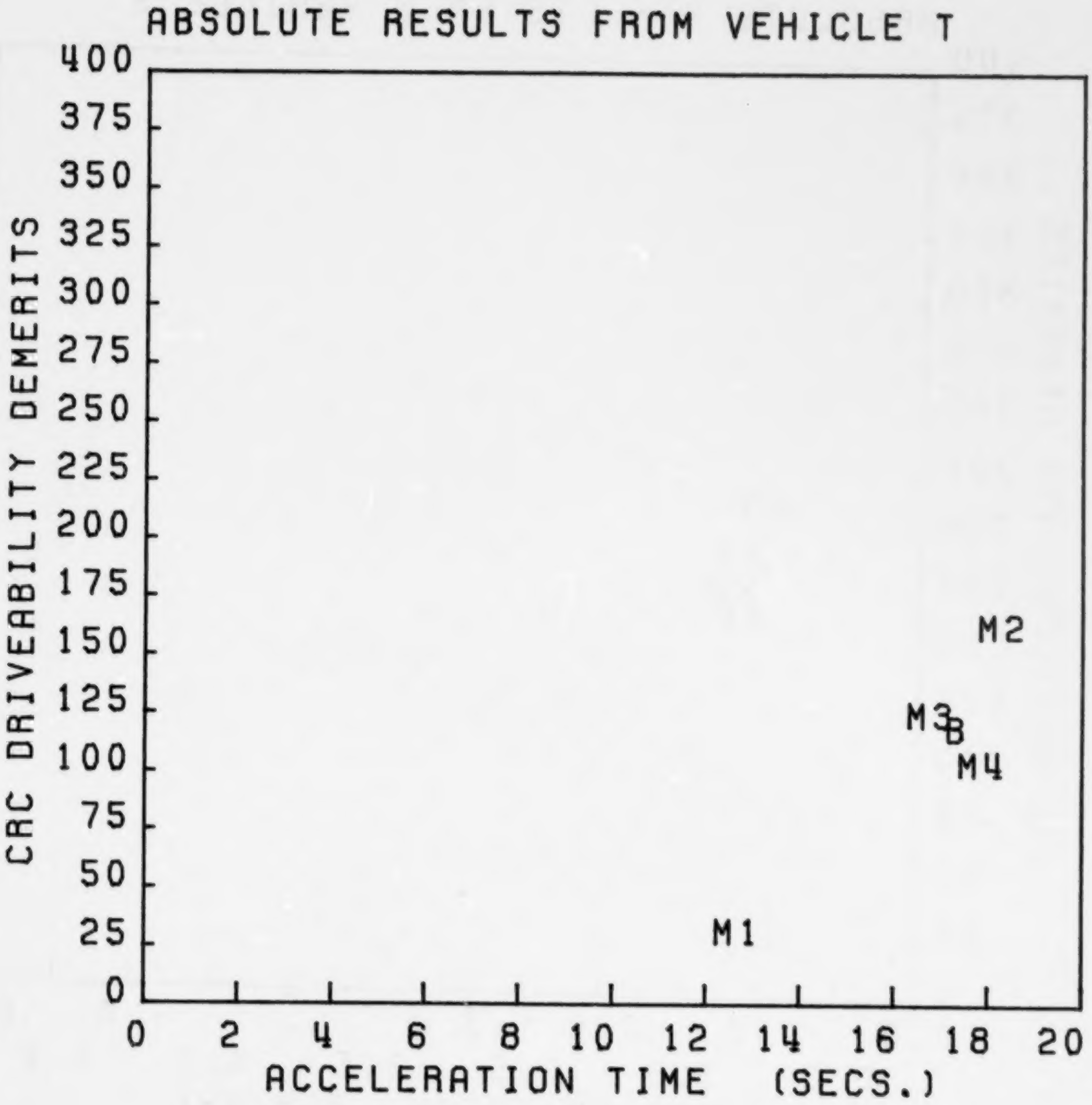

ABSOLUTE RESULTS FROM VEHICLE S
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)
M3
M4
B
M2
M1

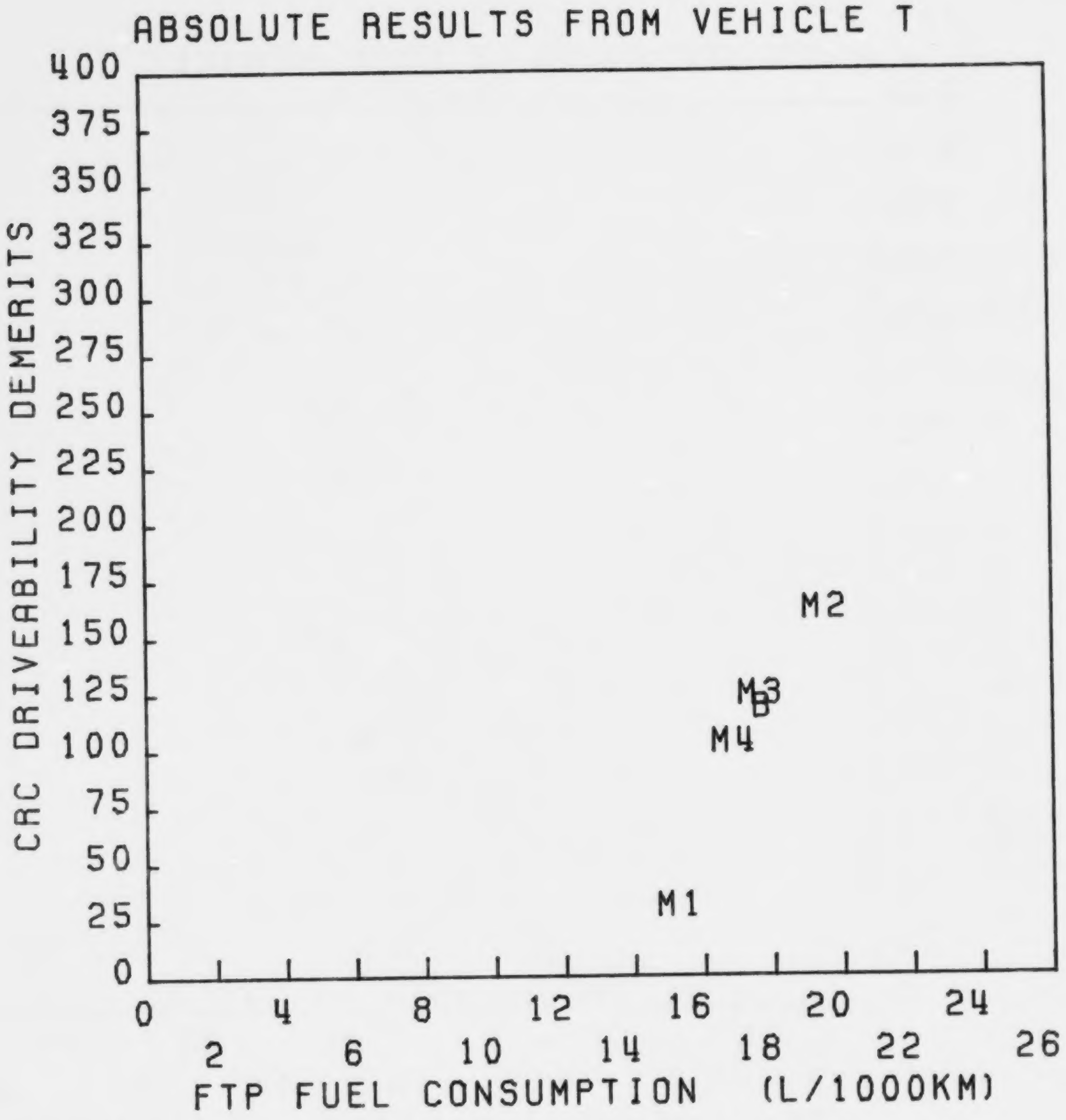

ABSOLUTE RESULTS FROM VEHICLE S
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M3
M4
B
M2
M1



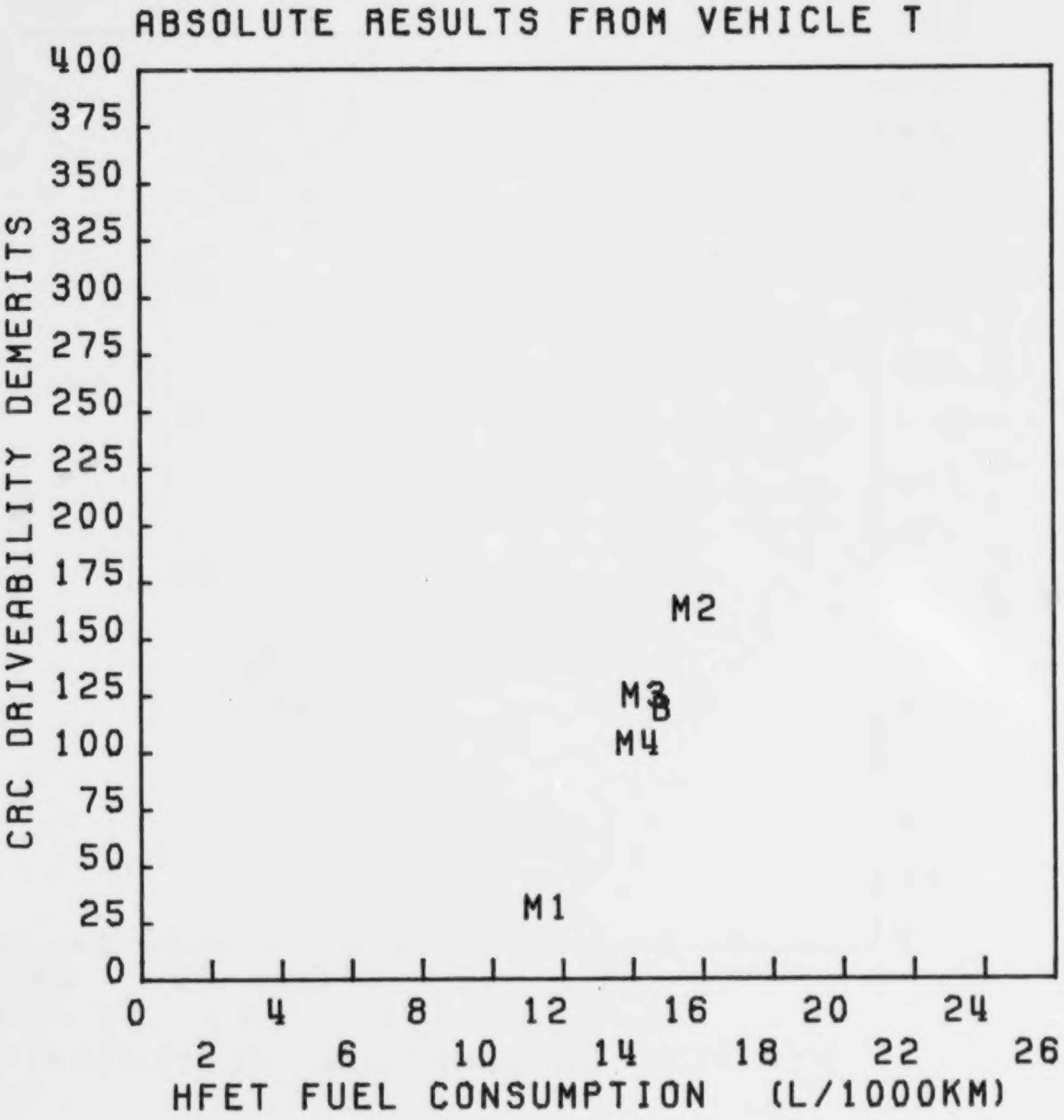
ABSOLUTE RESULTS FROM VEHICLE S

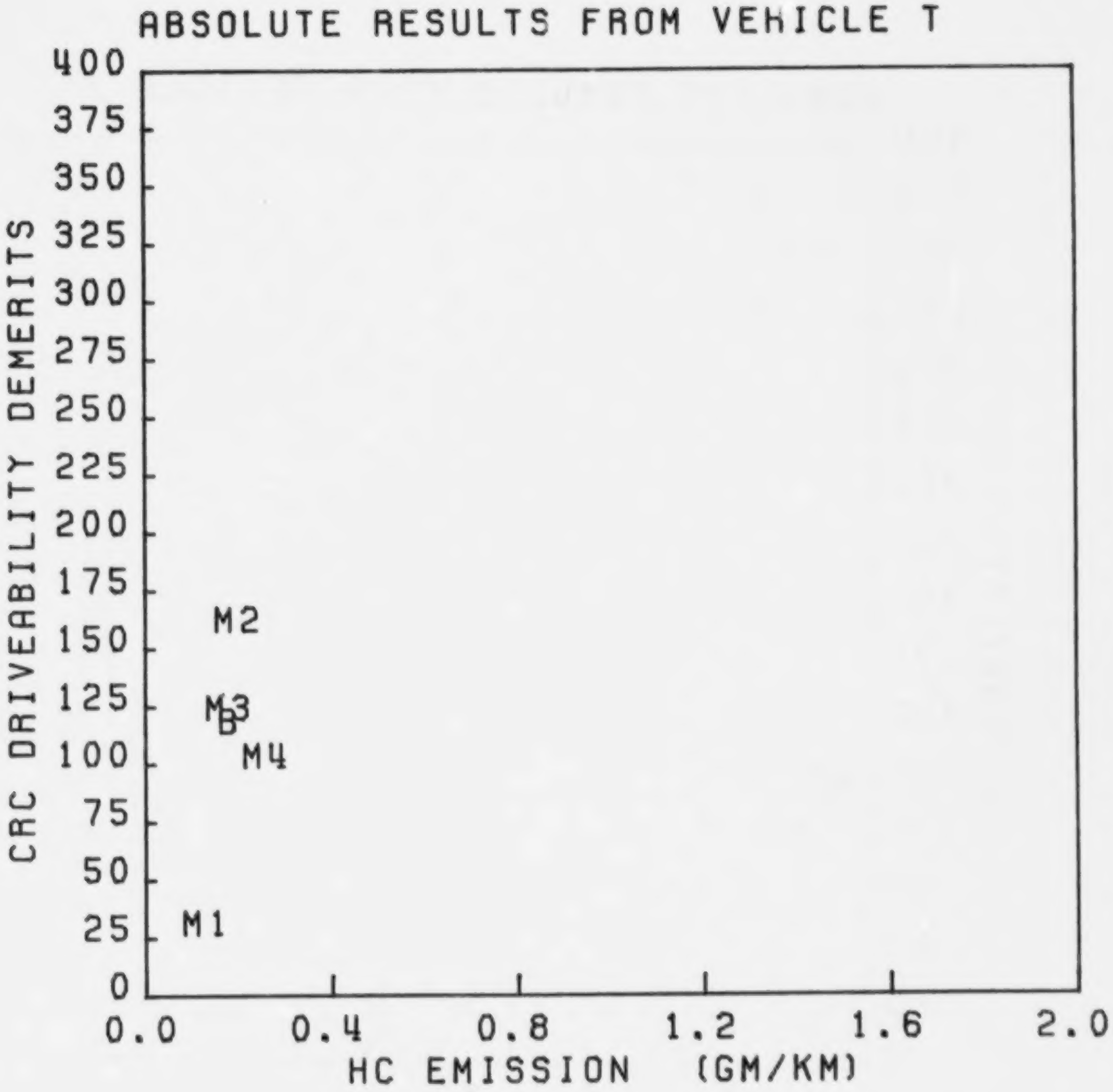

ABSOLUTE RESULTS FROM VEHICLE S
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)
M3
M4
B
M2
M1

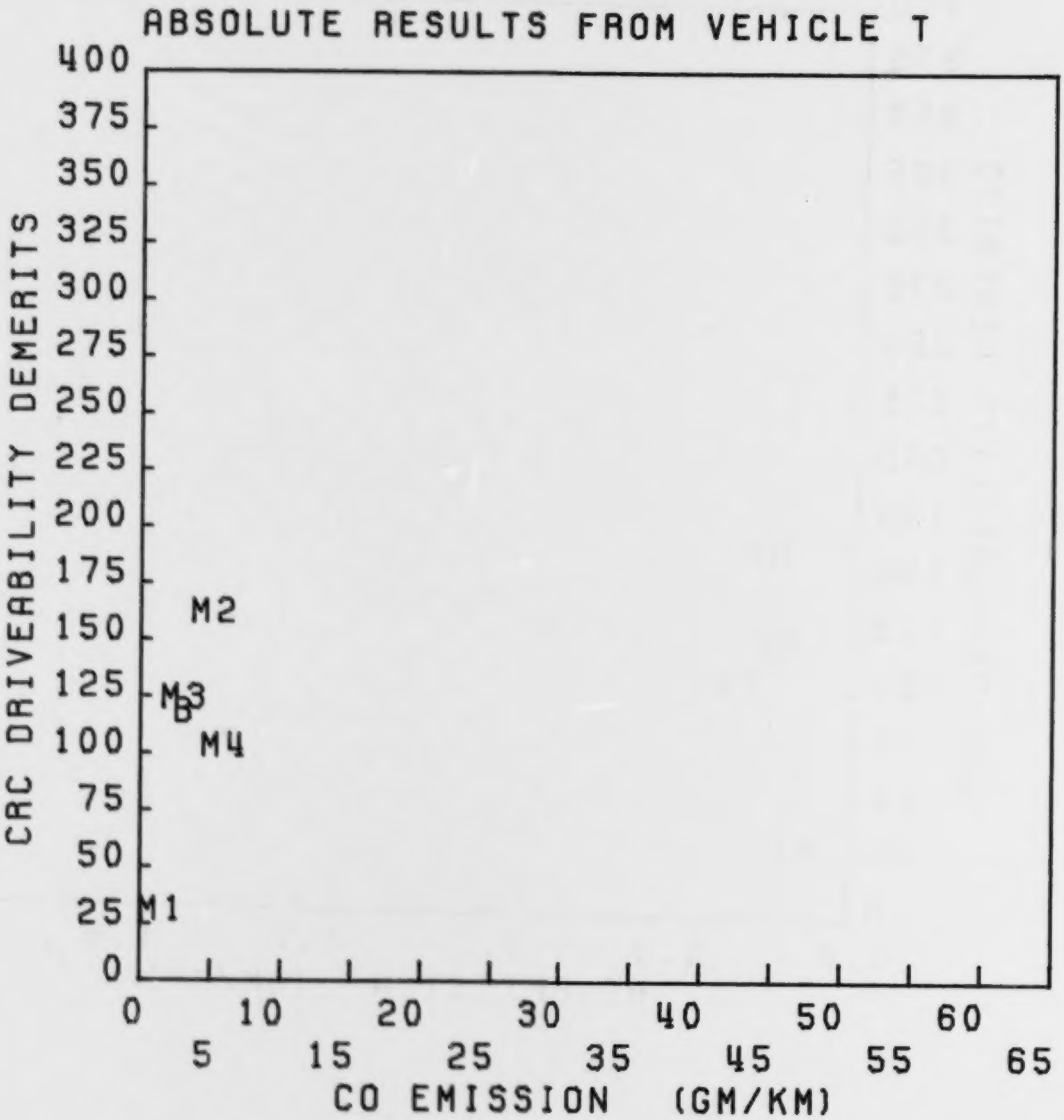

ABSOLUTE RESULTS FROM VEHICLE T
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)
M2
M3
B
M4
M1

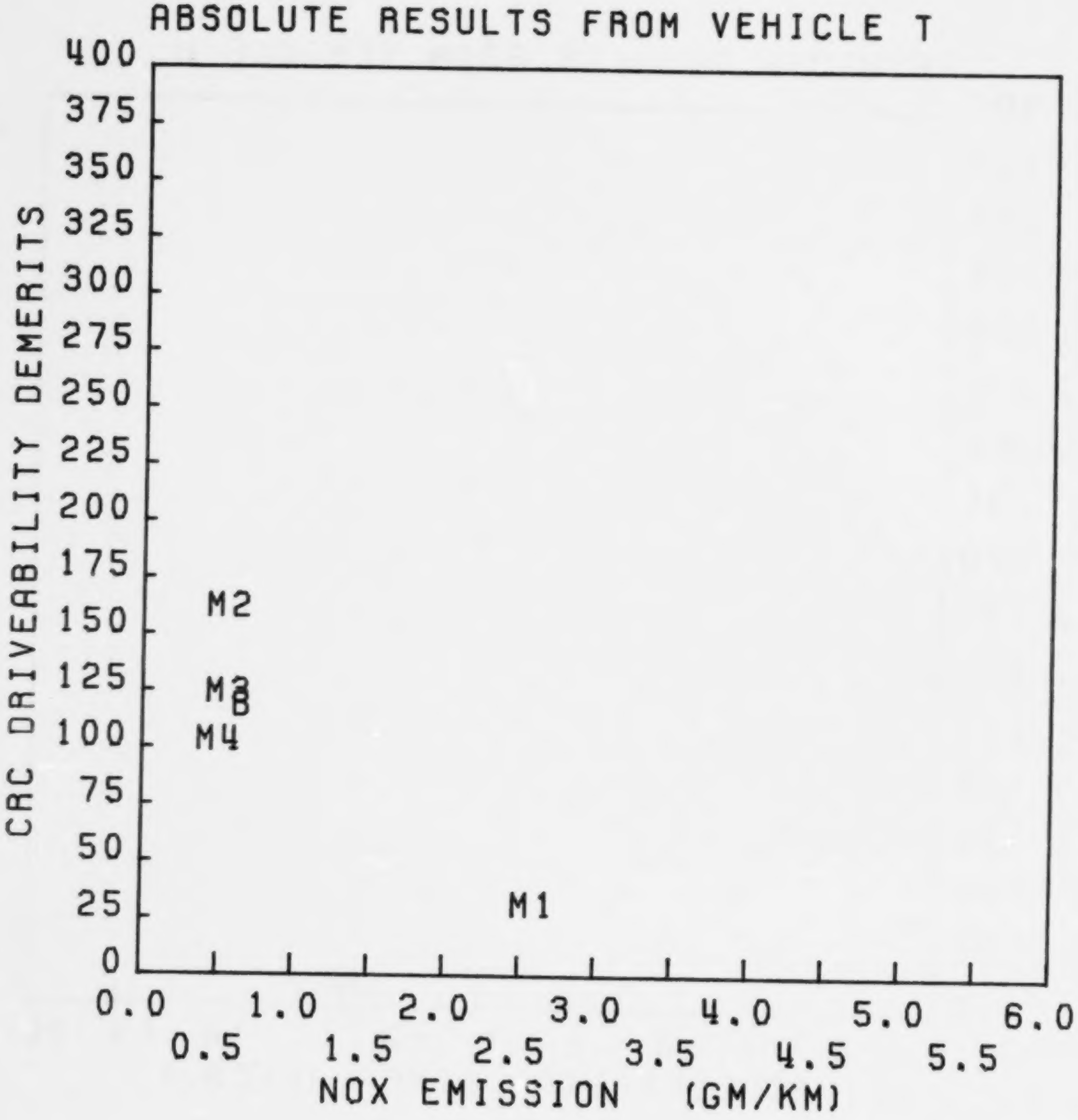


ABSOLUTE RESULTS FROM VEHICLE T

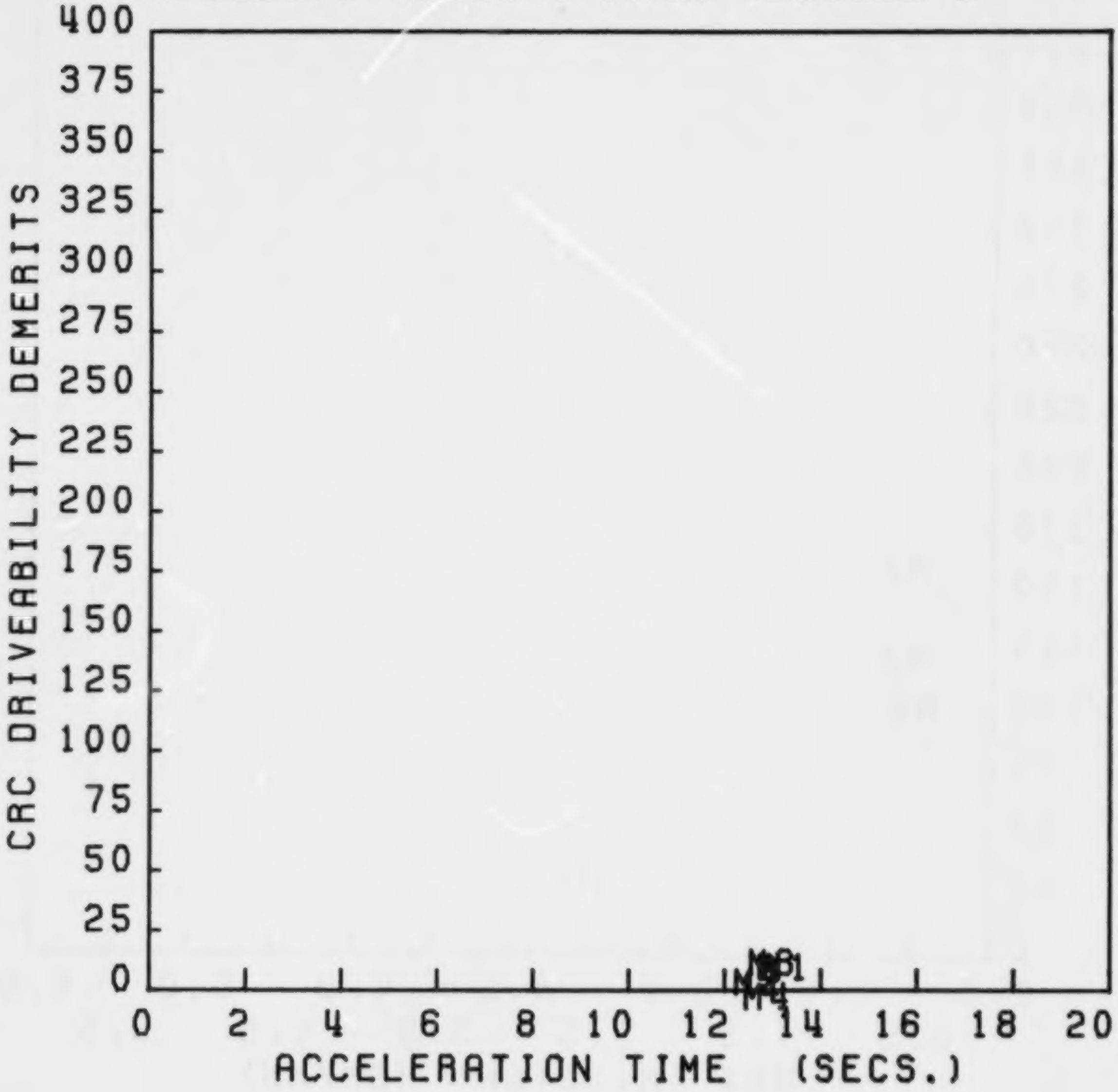

ABSOLUTE RESULTS FROM VEHICLE T
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M2
M3
B
M4
M1
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

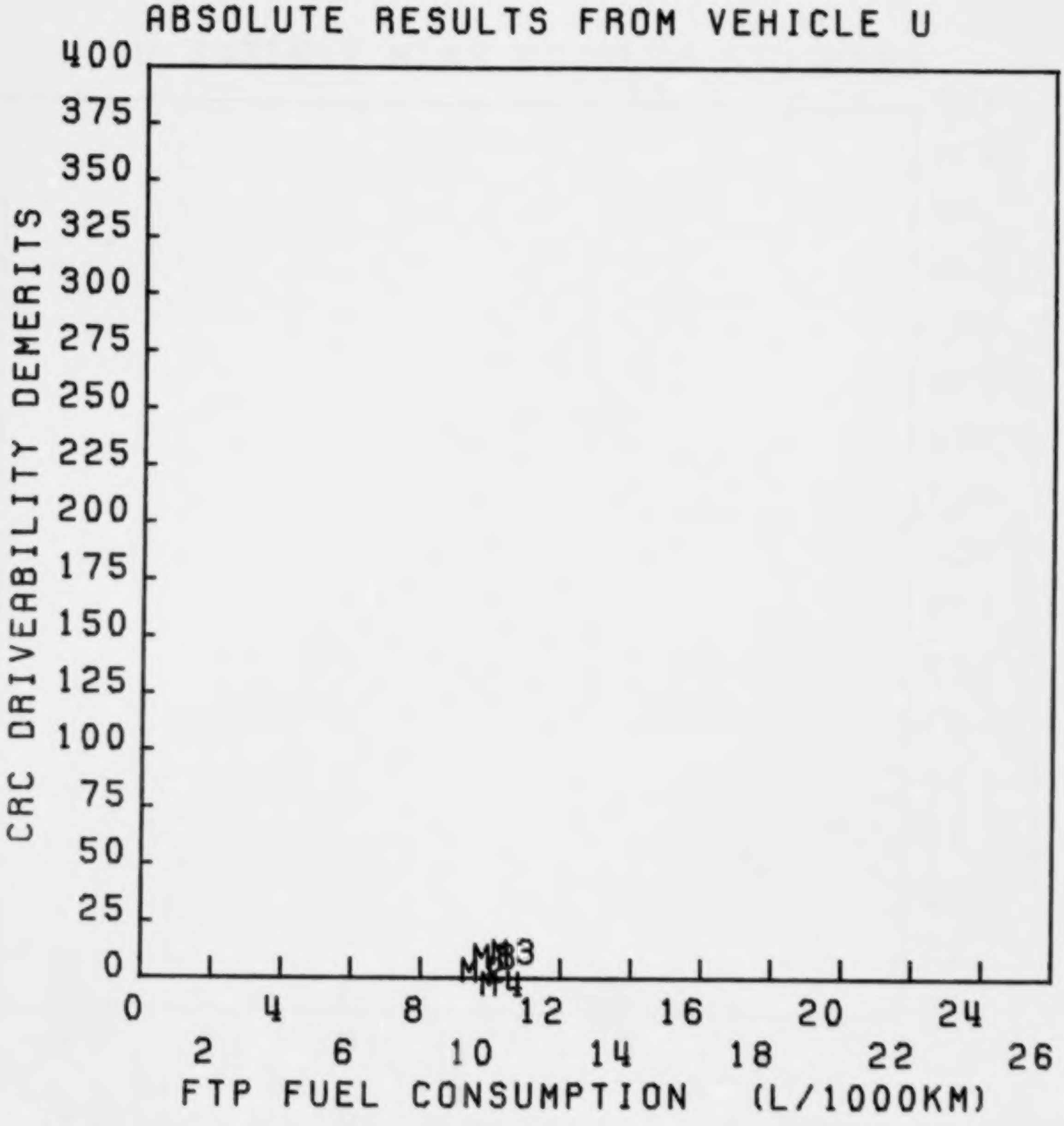

ABSOLUTE RESULTS FROM VEHICLE T
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M2
M3
B
M4
M1
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)

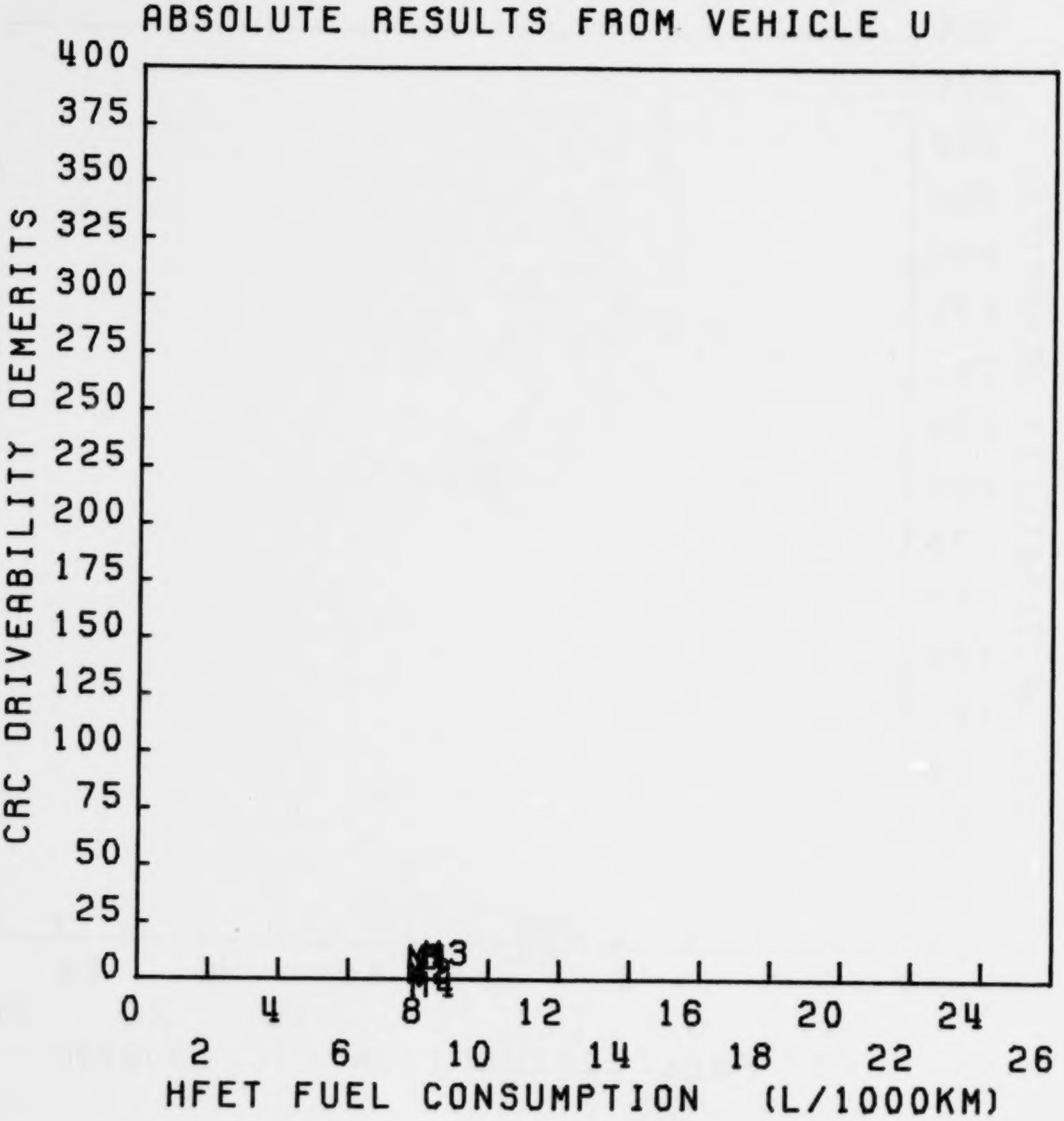

ABSOLUTE RESULTS FROM VEHICLE T
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
CO EMISSION (GM/KM)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
M1
M2
M3
B
M4

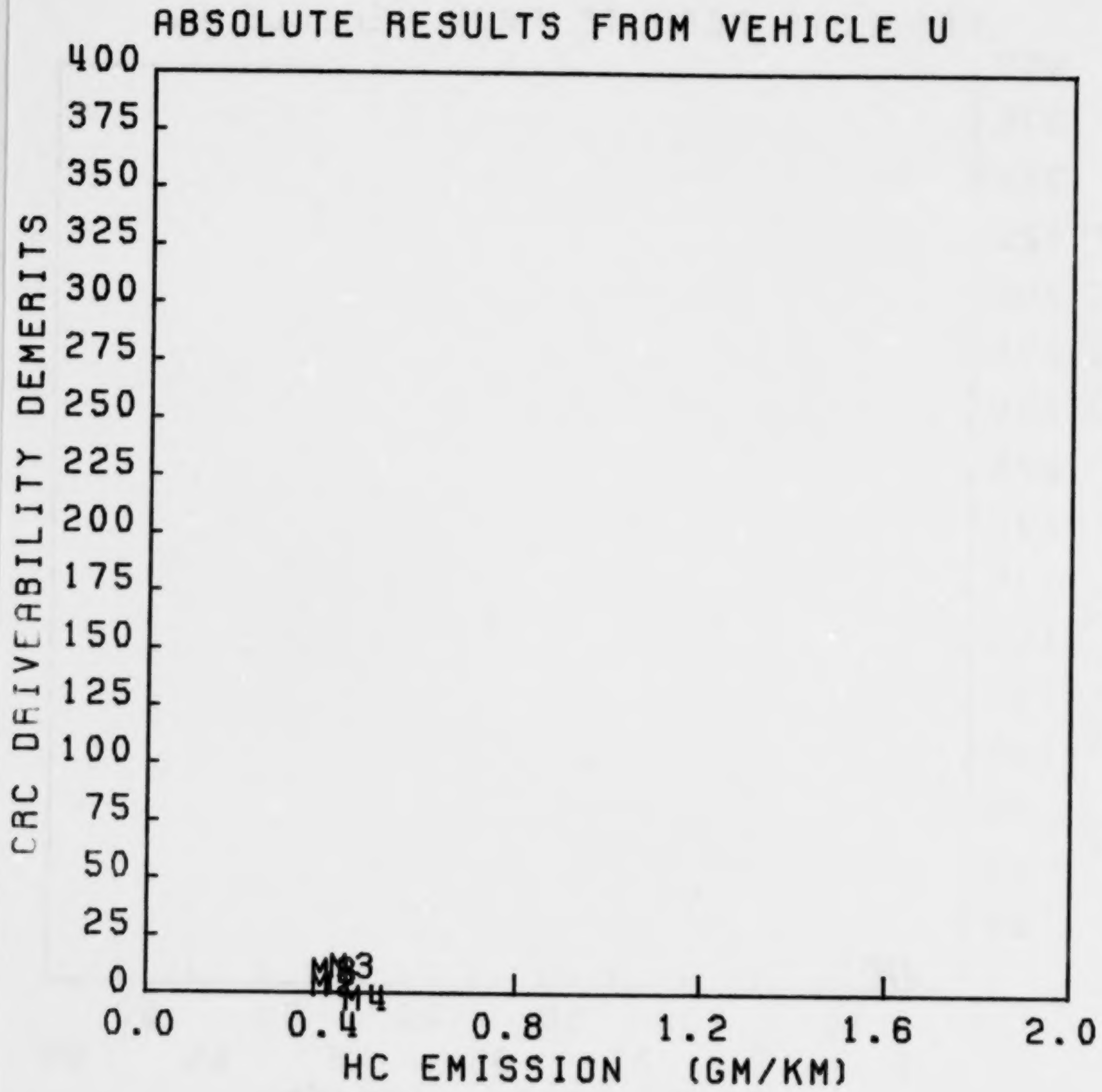
ABSOLUTE RESULTS FROM VEHICLE T
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M2
M3
B
M4
M1
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)

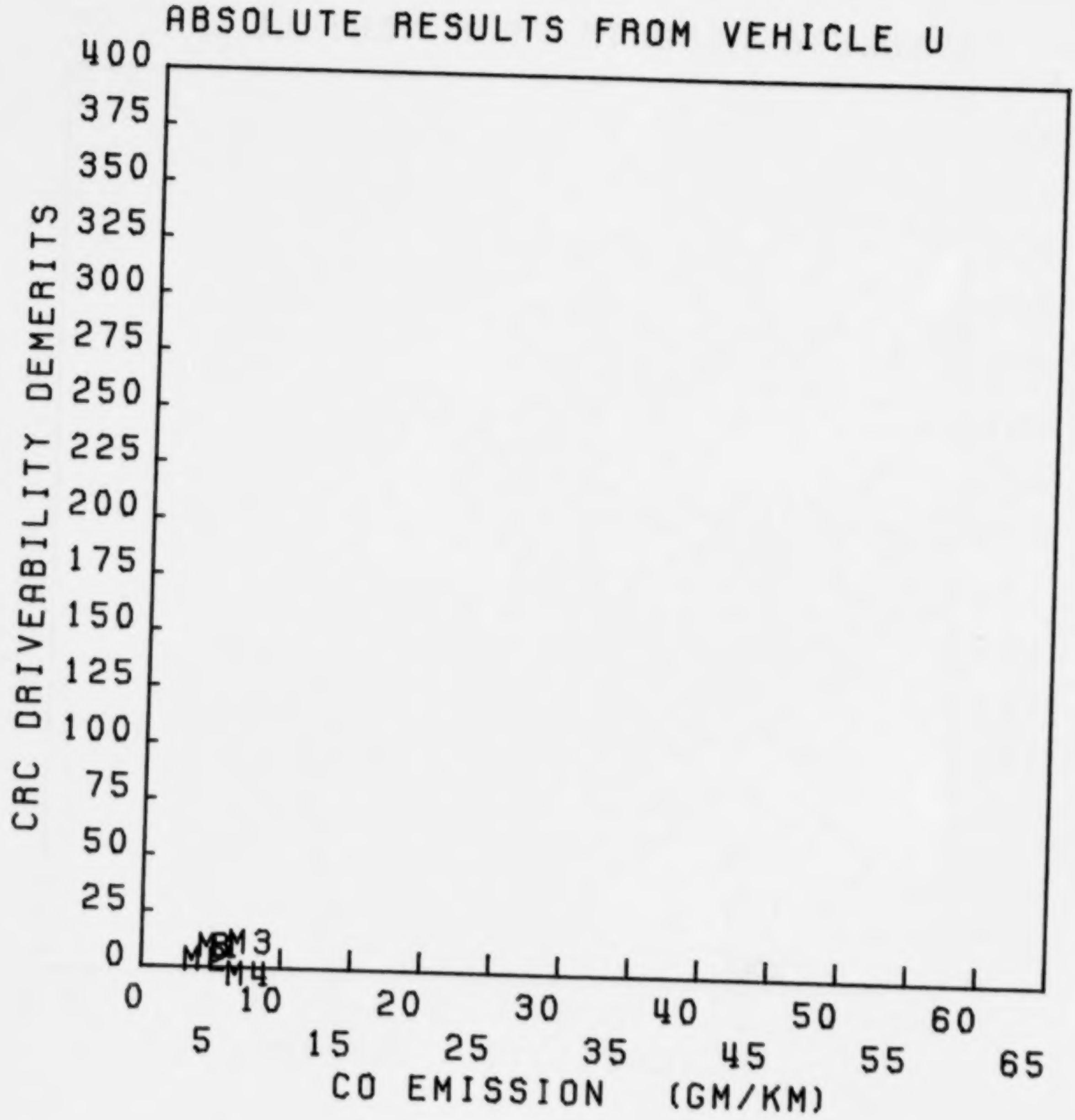
ABSOLUTE RESULTS FROM VEHICLE U

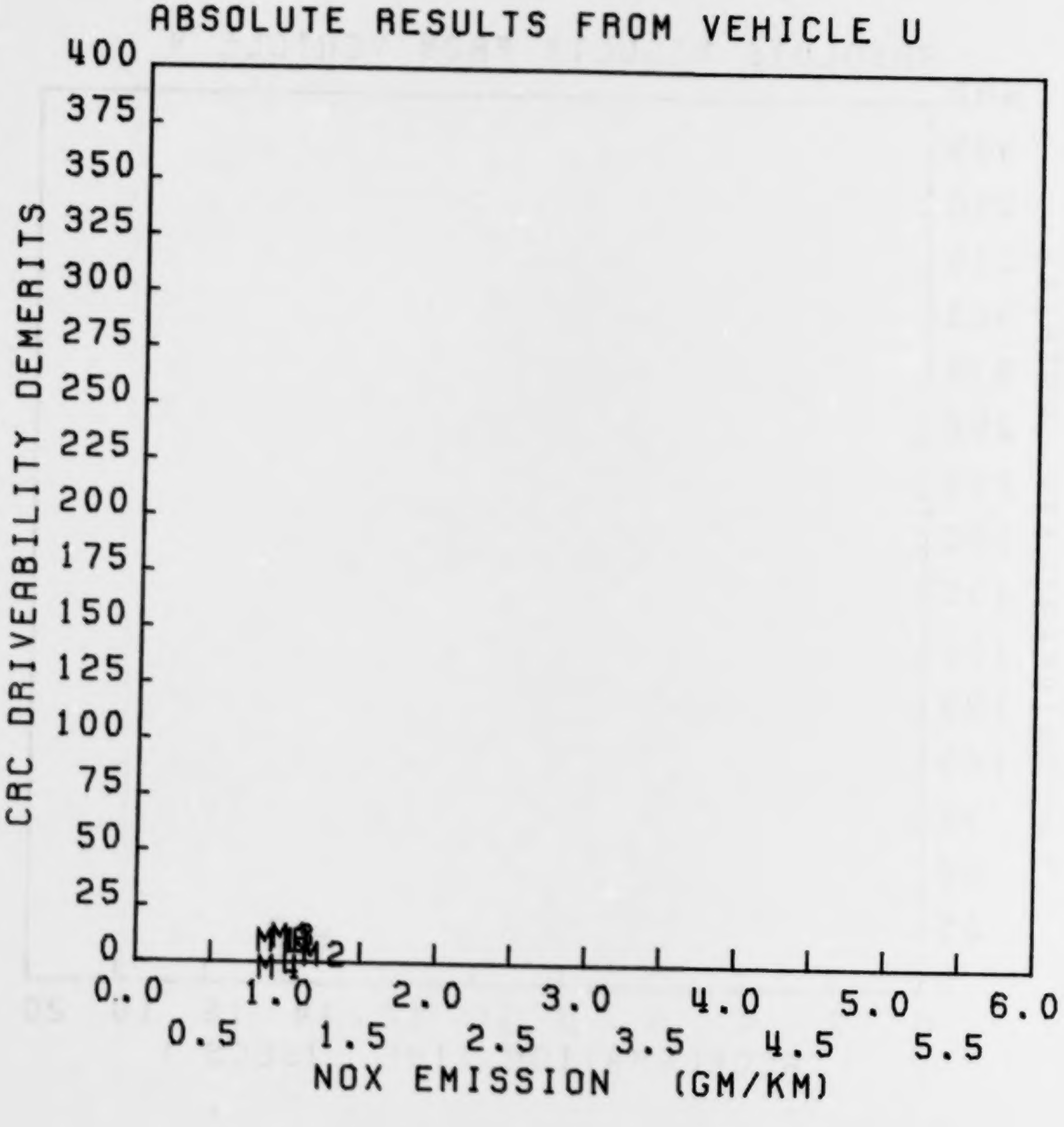


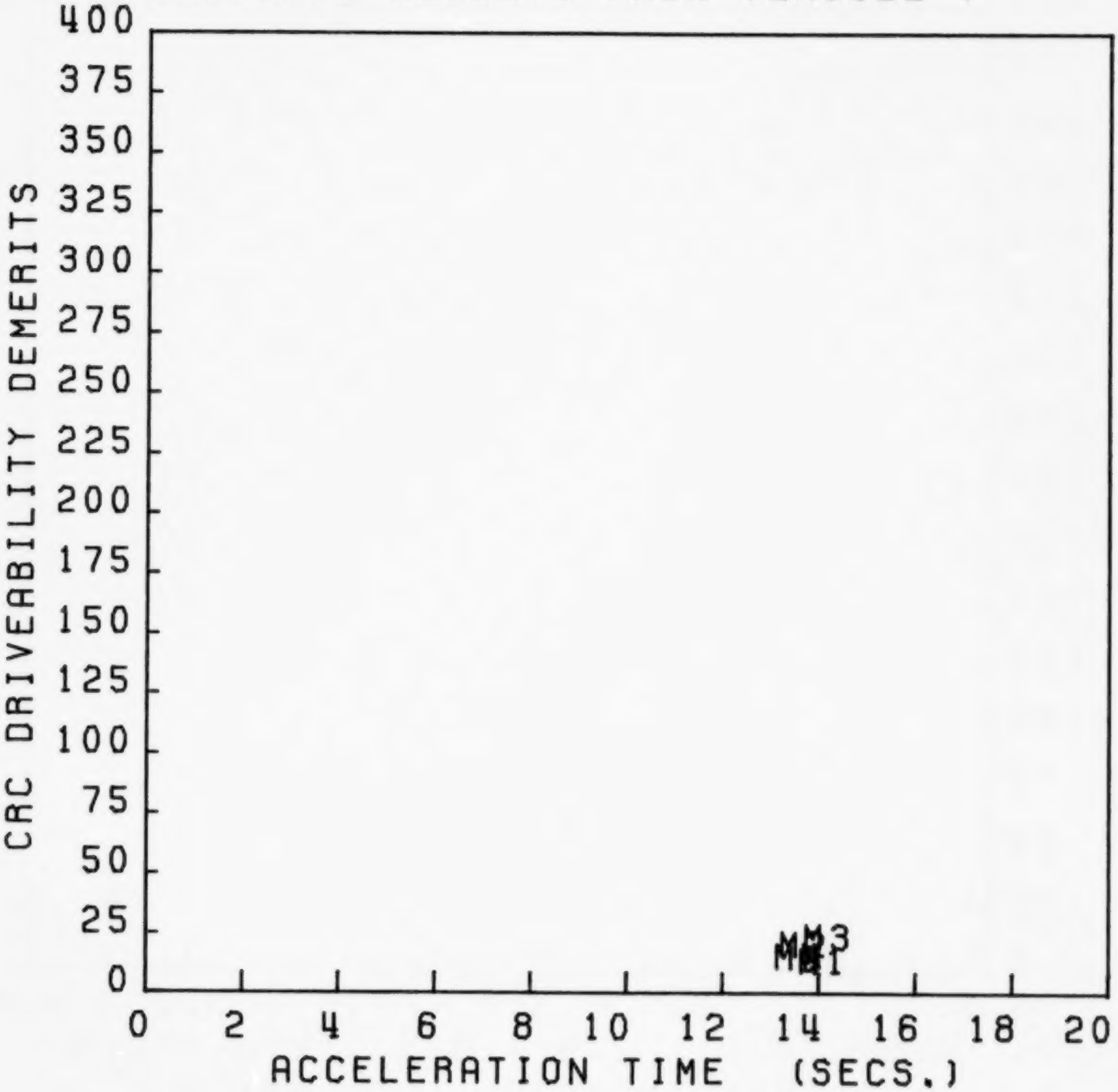

ABSOLUTE RESULTS FROM VEHICLE U
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M4
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)


ABSOLUTE RESULTS FROM VEHICLE U
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M4
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

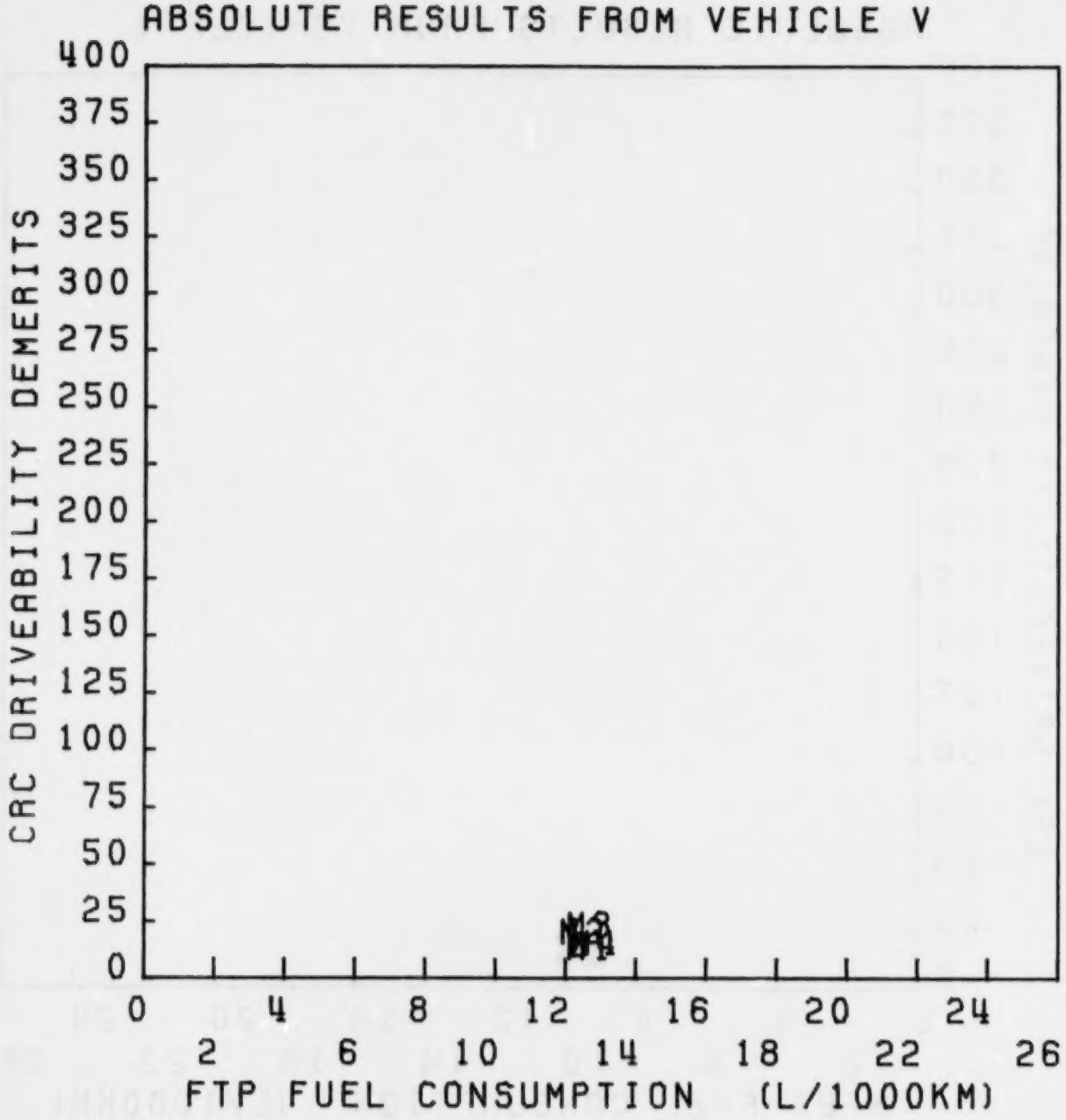

ABSOLUTE RESULTS FROM VEHICLE U
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
M3
M4

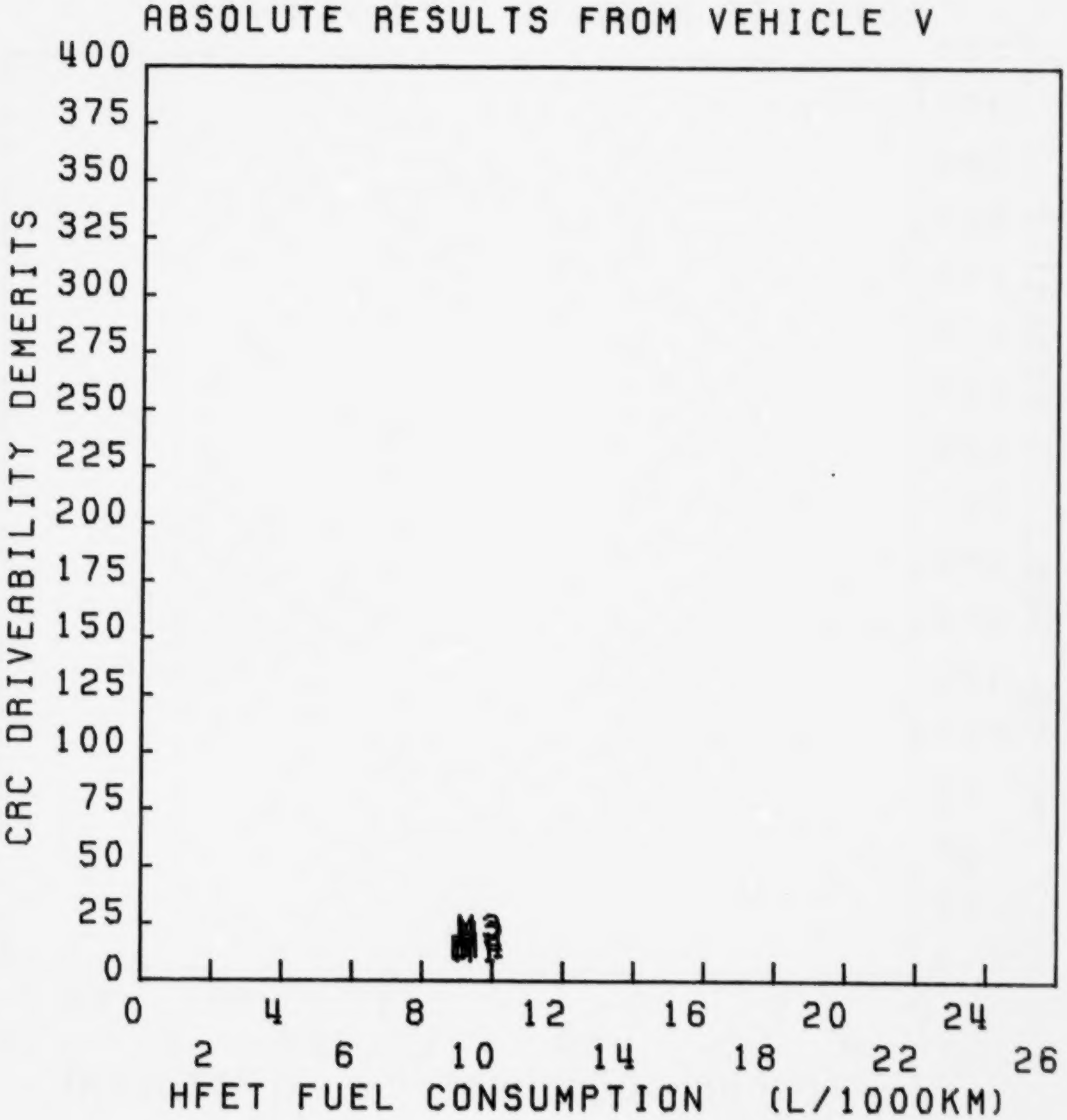

ABSOLUTE RESULTS FROM VEHICLE U
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

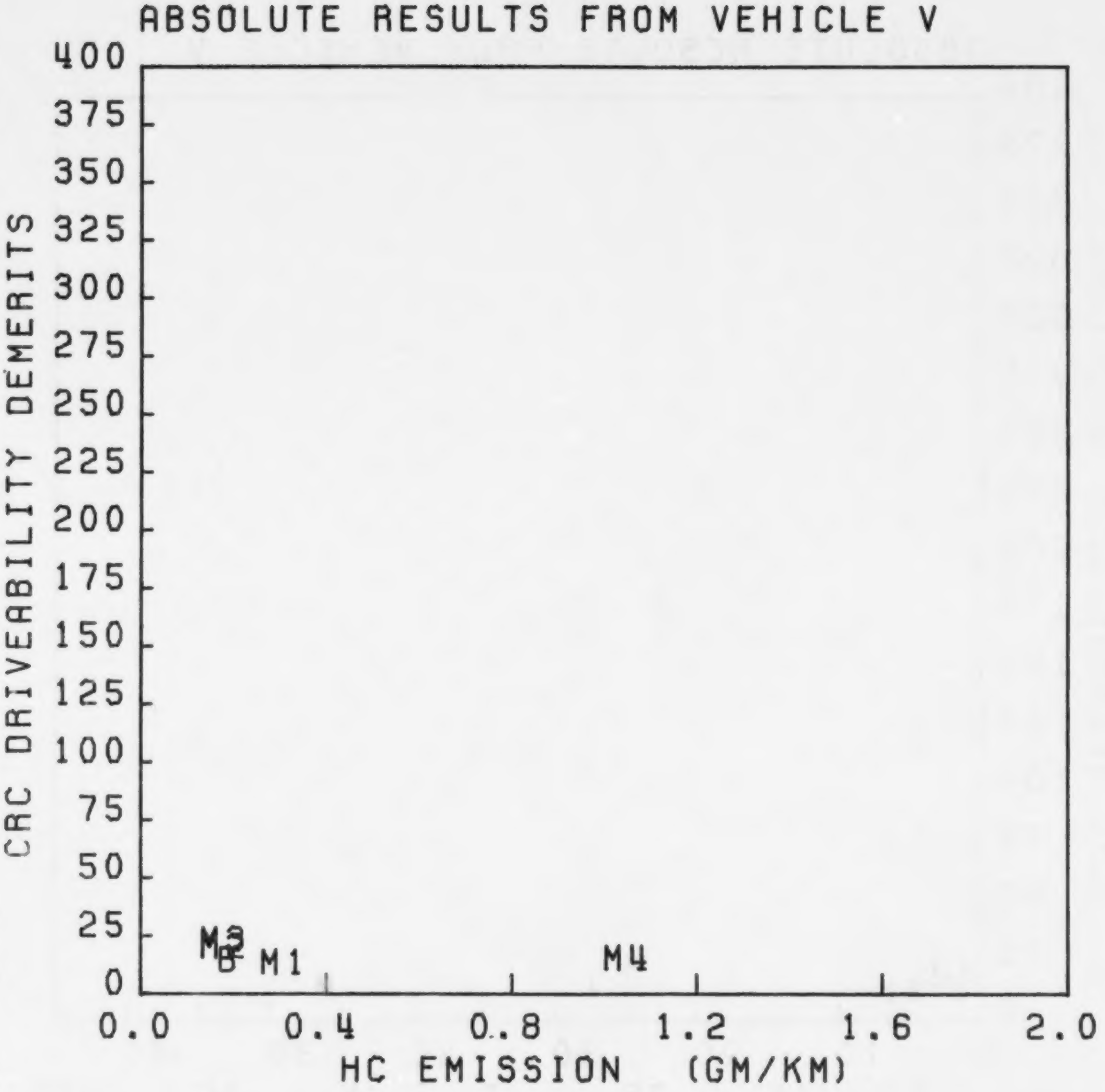

ABSOLUTE RESULTS FROM VEHICLE U
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M1
M3
M2
M4
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

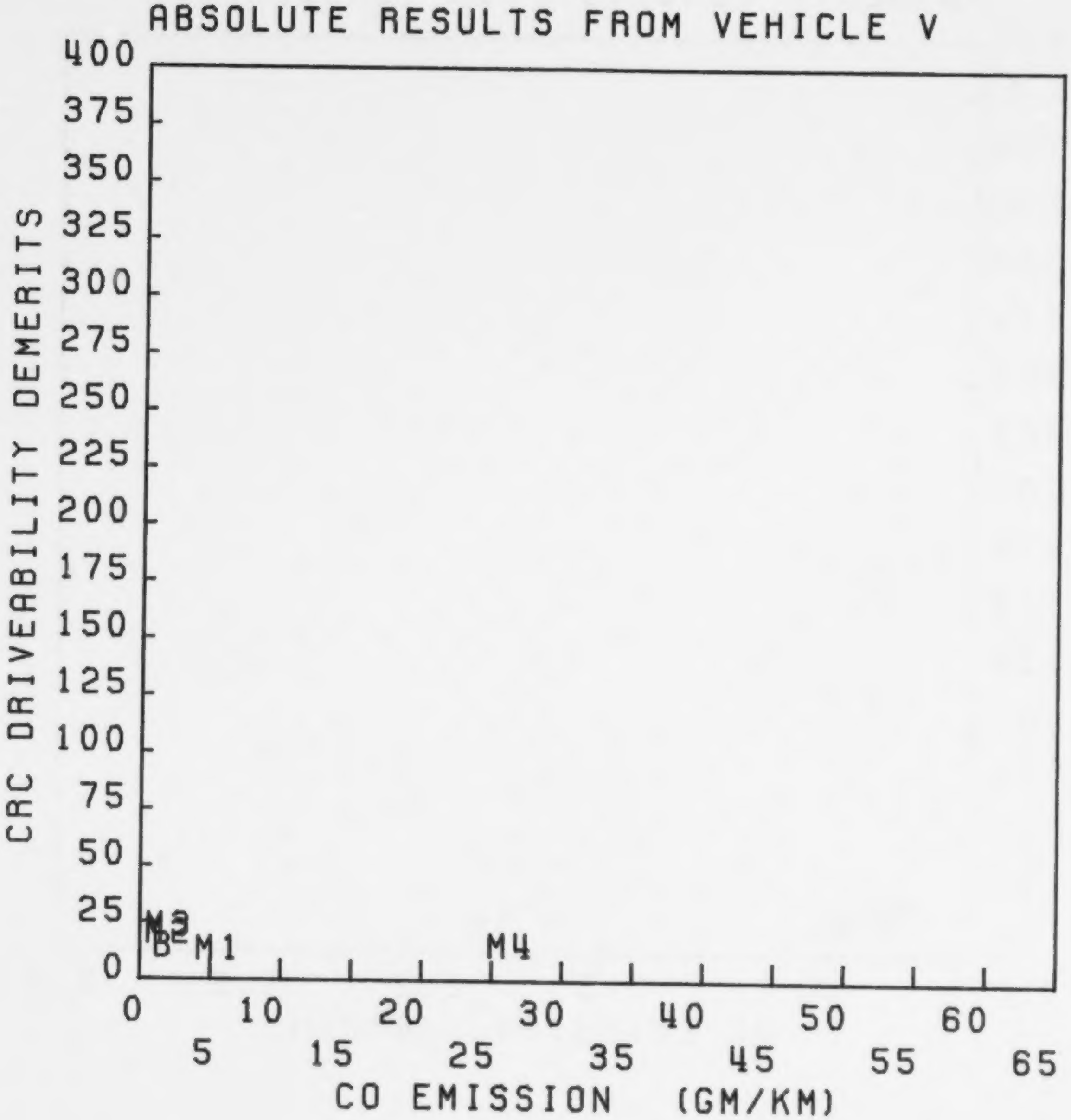


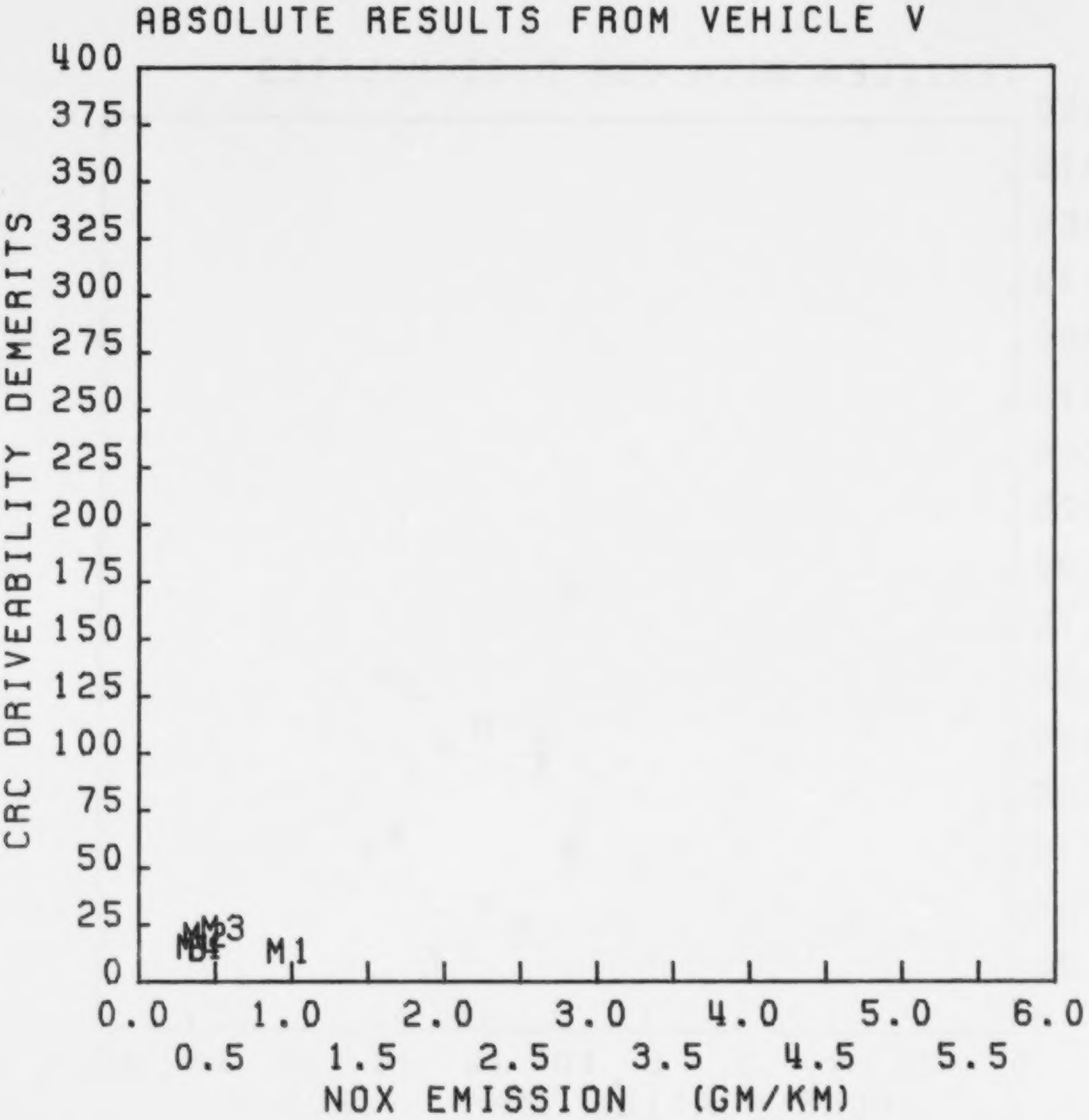
ABSOLUTE RESULTS FROM VEHICLE V

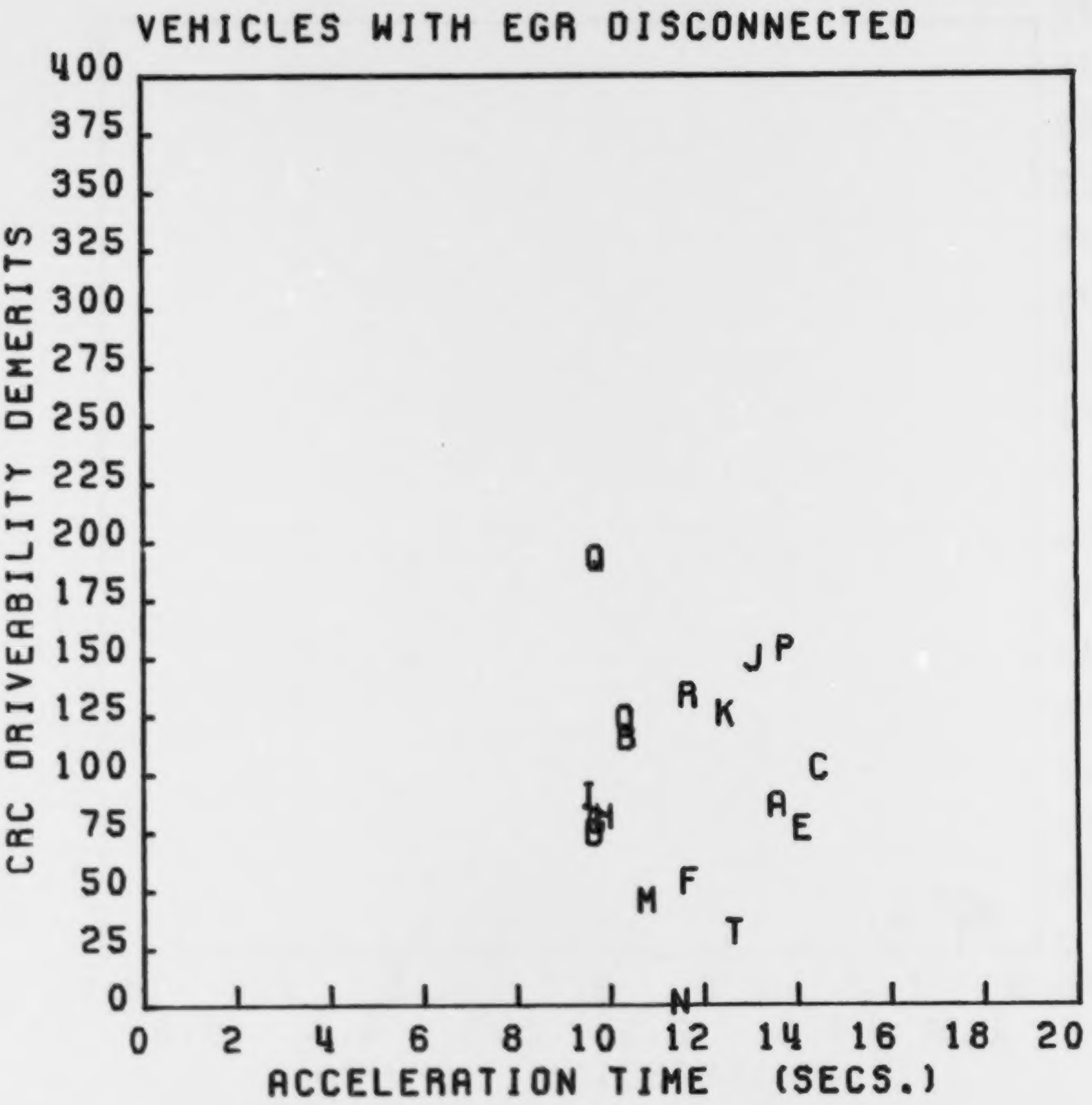

ABSOLUTE RESULTS FROM VEHICLE V
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)

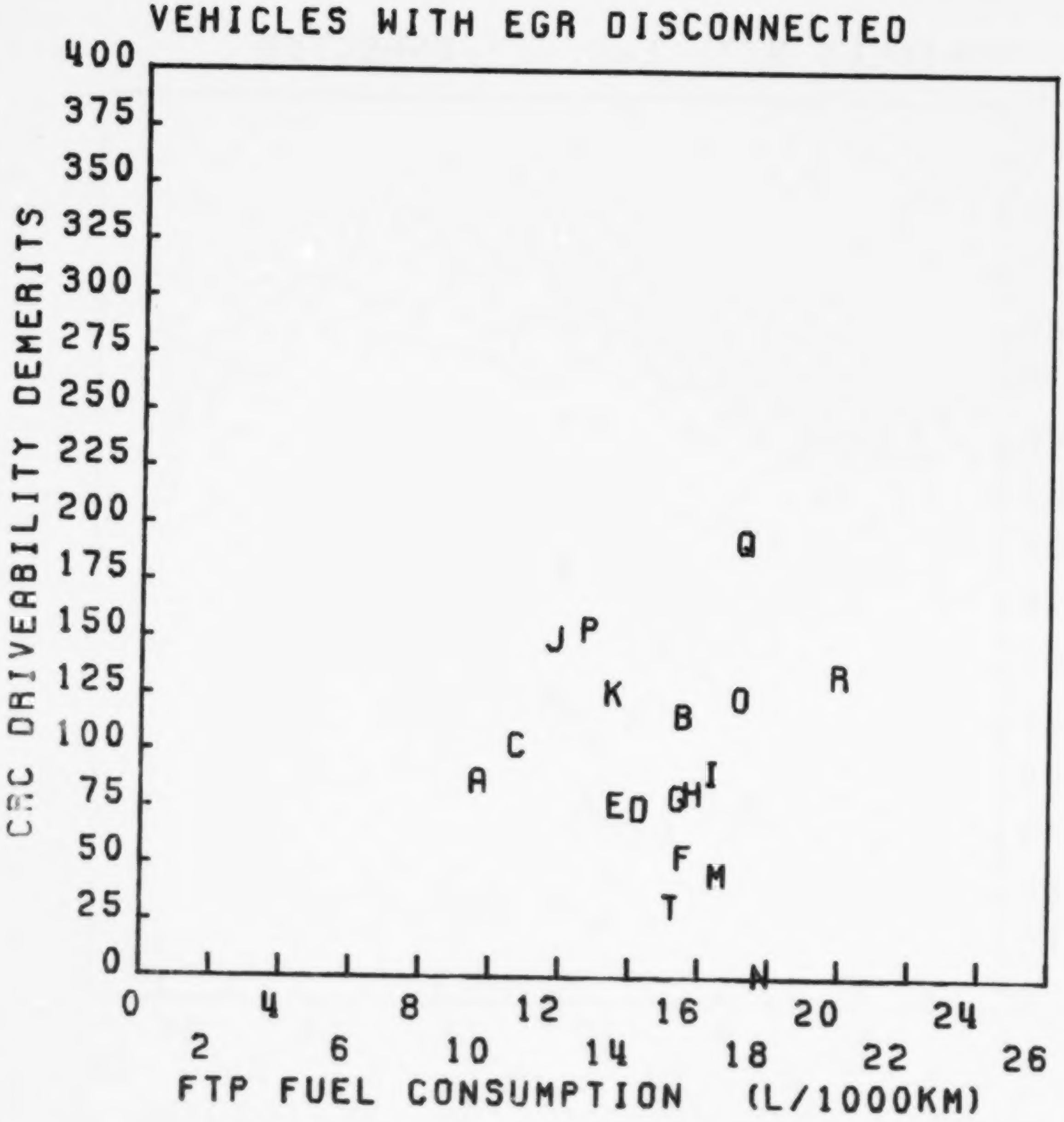

ABSOLUTE RESULTS FROM VEHICLE V
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M
3
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)


ABSOLUTE RESULTS FROM VEHICLE V
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M2
B
M1
M4
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)

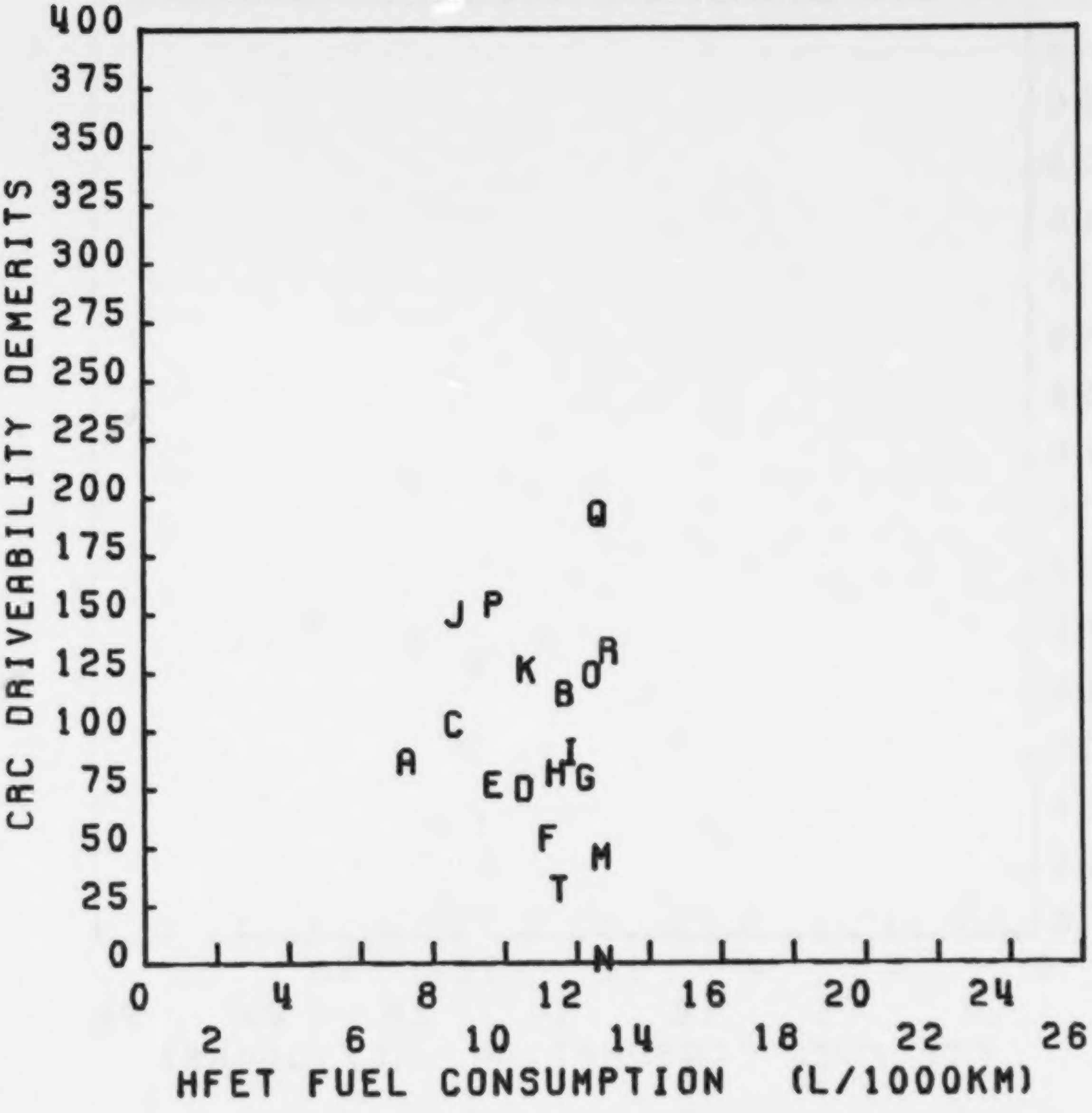

ABSOLUTE RESULTS FROM VEHICLE V
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M2
B
M1
M4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)


ABSOLUTE RESULTS FROM VEHICLE V
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
M3
M1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

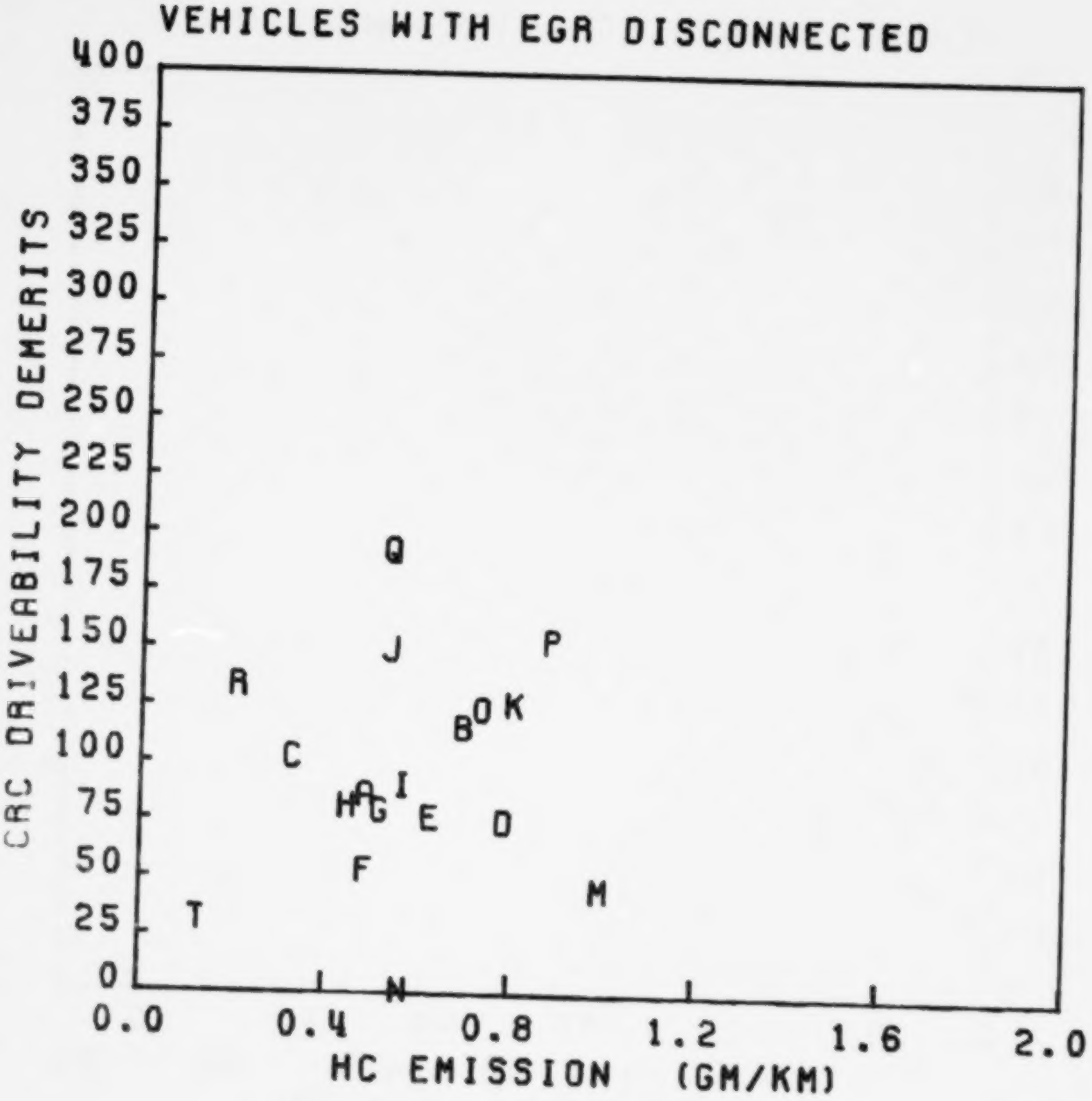

VEHICLES WITH EGR DISCONNECTED
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
ACCELERATION TIME (SECS.)
0
2
4
6
8
10
12
14
16
18
20
Q
J
P
R
K
D
B
C
L
G
H
D
A
E
F
M
T
N

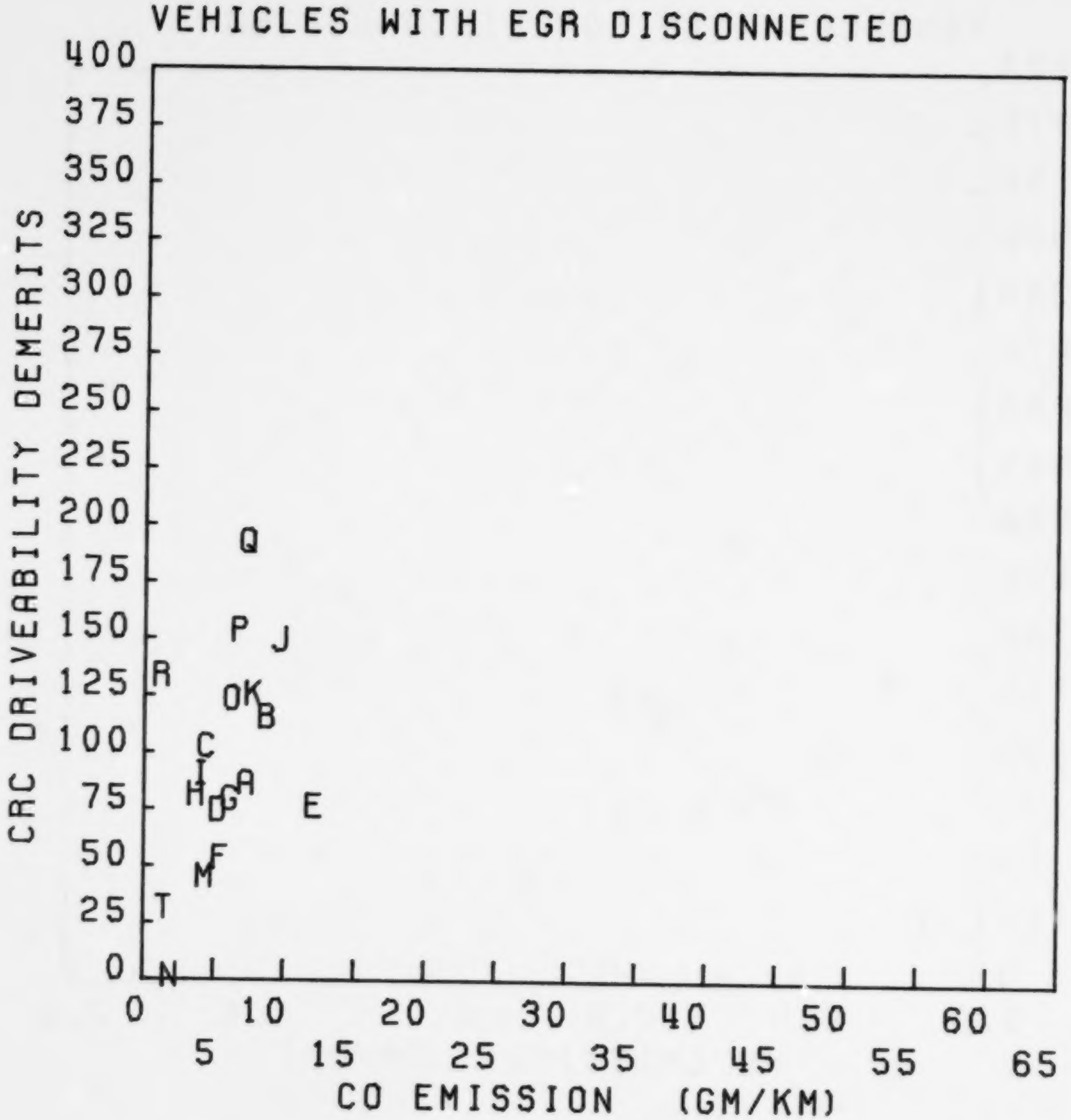


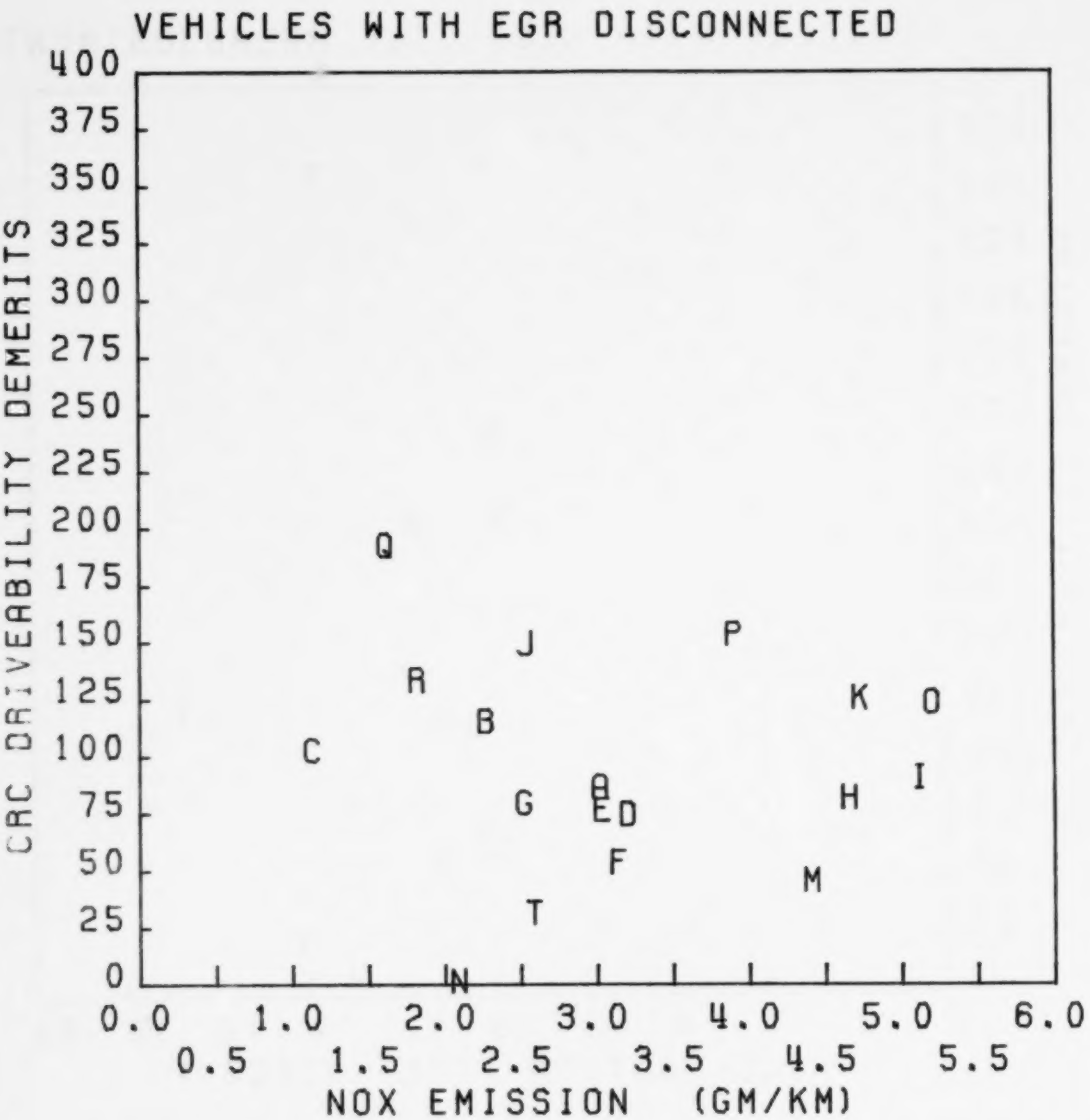
VEHICLES WITH EGR DISCONNECTED
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)
Q
J
P
K
R
O
B
C
A
I
E
D
G
H
F
M
T
N

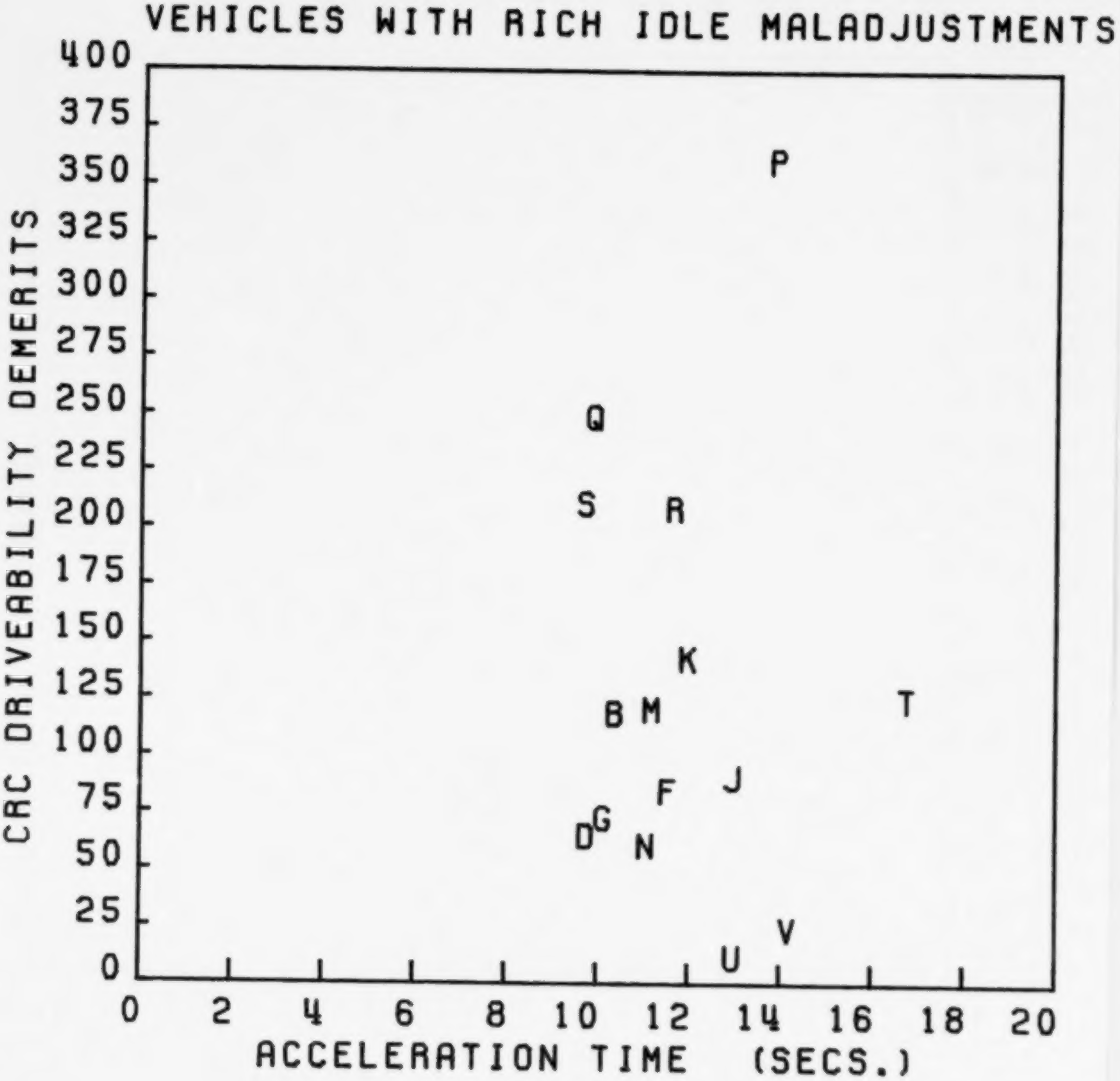


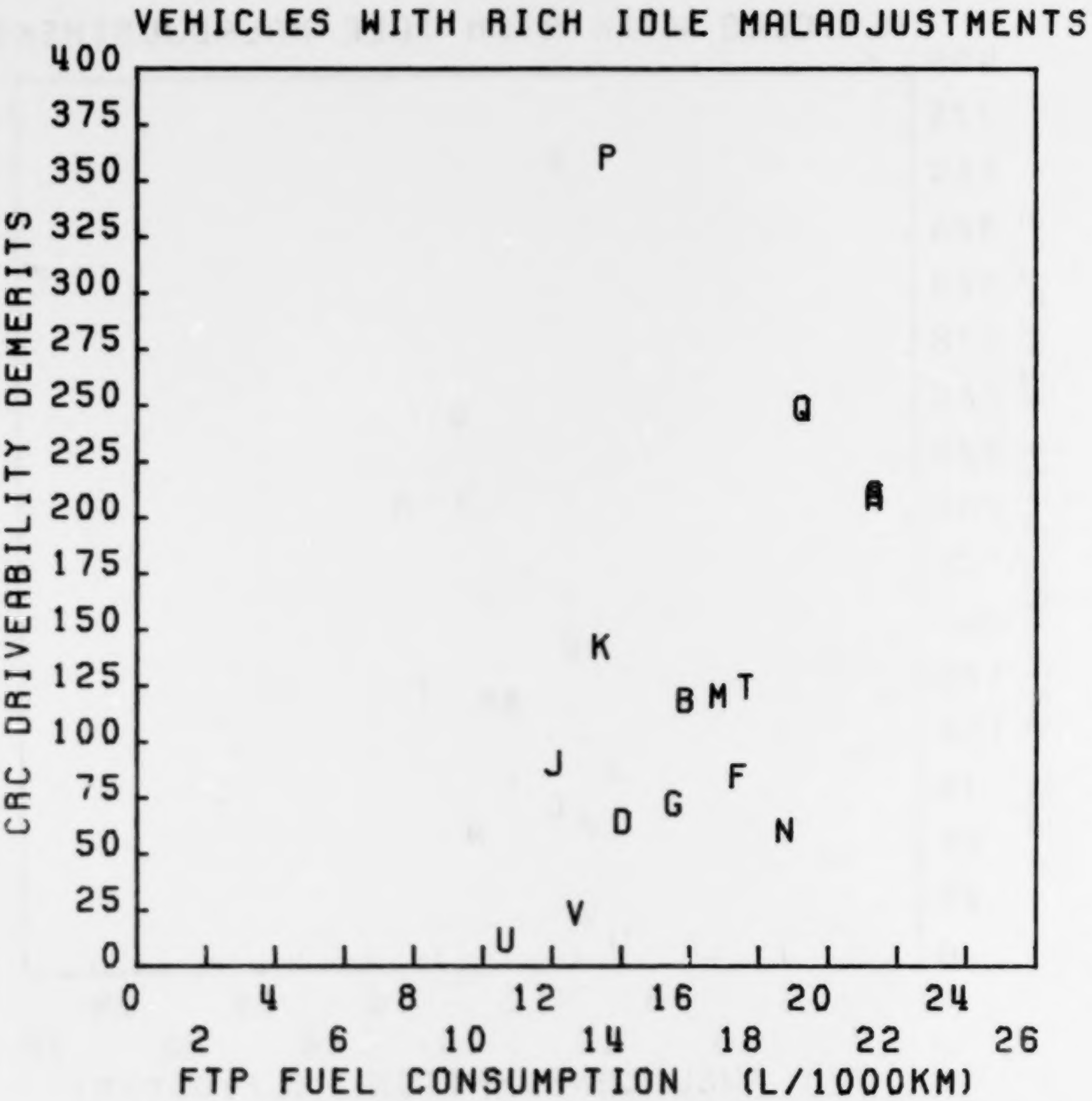
VEHICLES WITH EGR DISCONNECTED

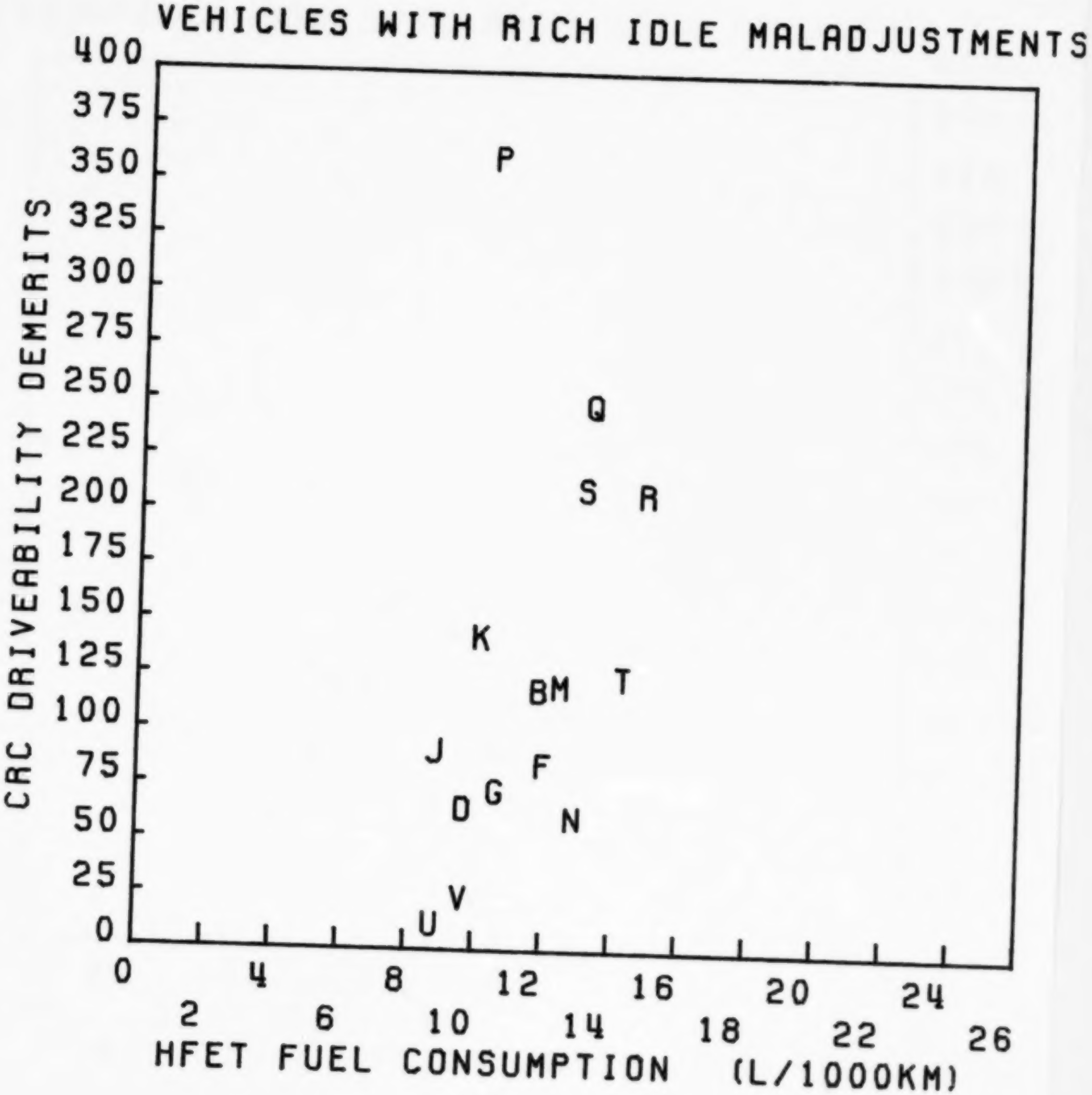

VEHICLES WITH EGR DISCONNECTED
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
Q
J
P
R
B
O
K
C
A
I
H
G
E
D
F
M
T
N

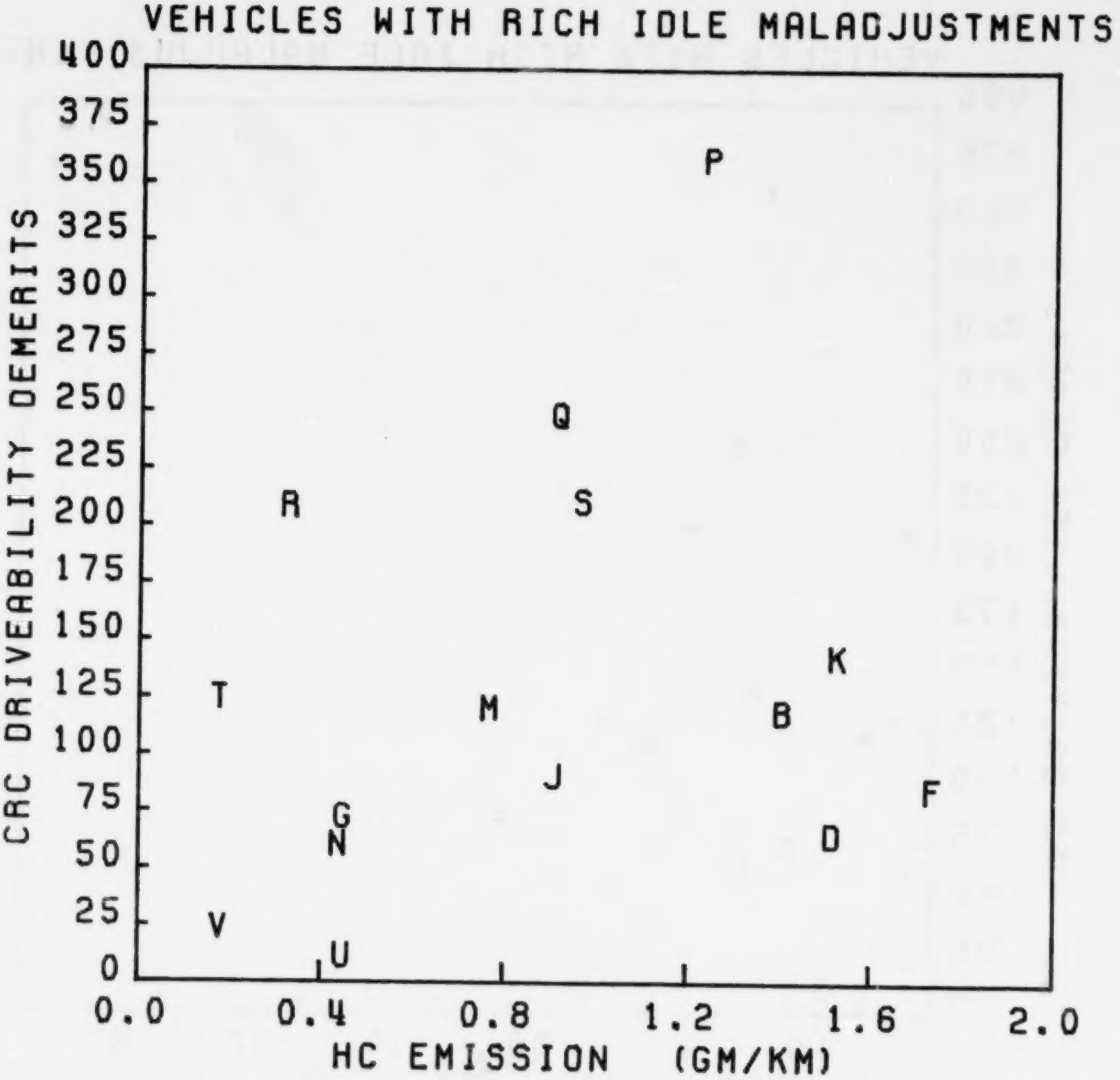

VEHICLES WITH EGR DISCONNECTED
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
CO EMISSION (GM/KM)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Q
P
J
R
O
K
B
C
I
H
D
G
A
E
F
M
T
N

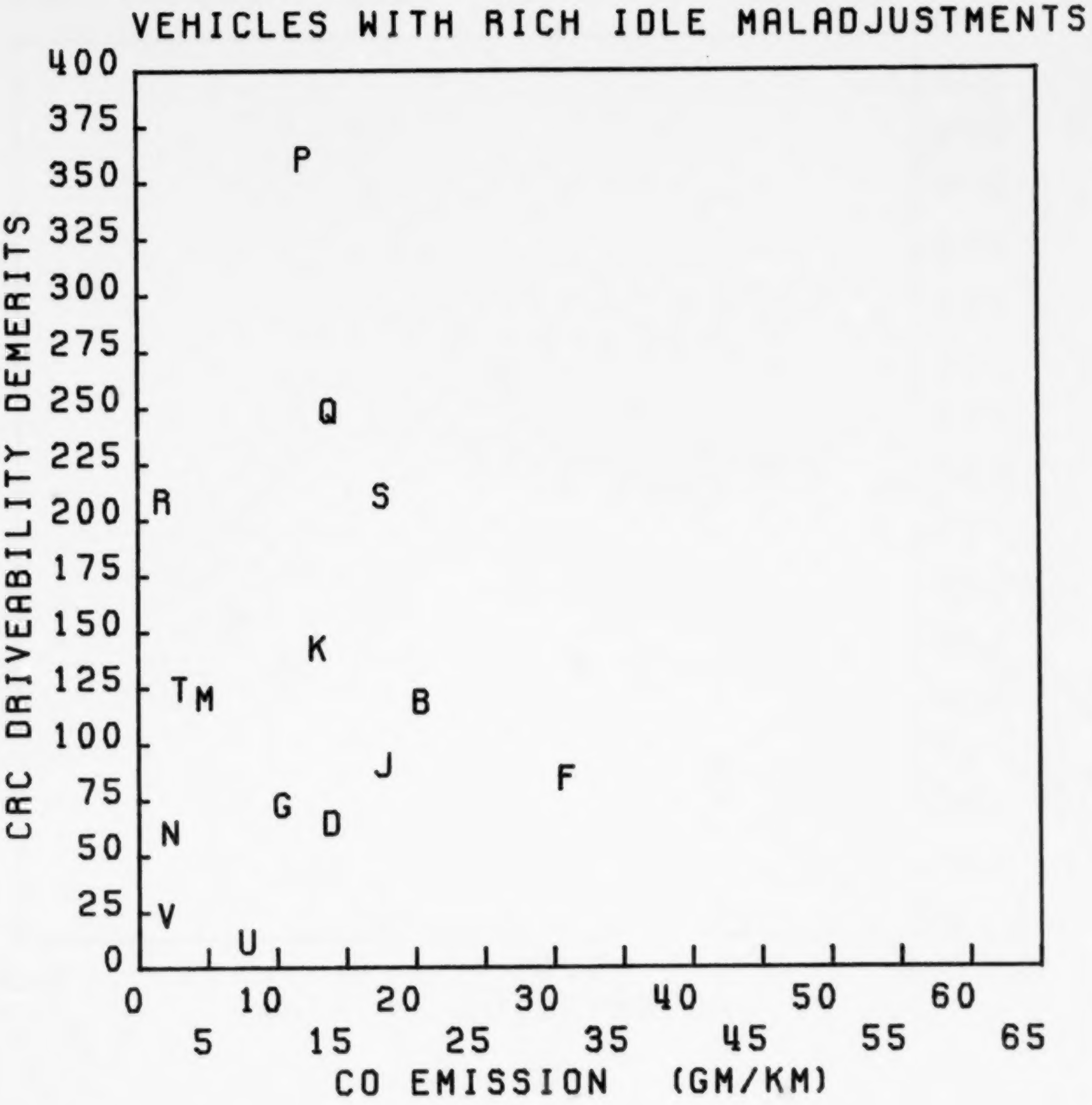

VEHICLES WITH EGR DISCONNECTED
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
Q
J
P
R
K
O
B
C
I
G
A
E
D
H
F
M
T
N
0.0
1.0
2.0
3.0
4.0
5.0
6.0
0.5
1.5
2.5
3.5
4.5
5.5
NOX EMISSION (GM/KM)

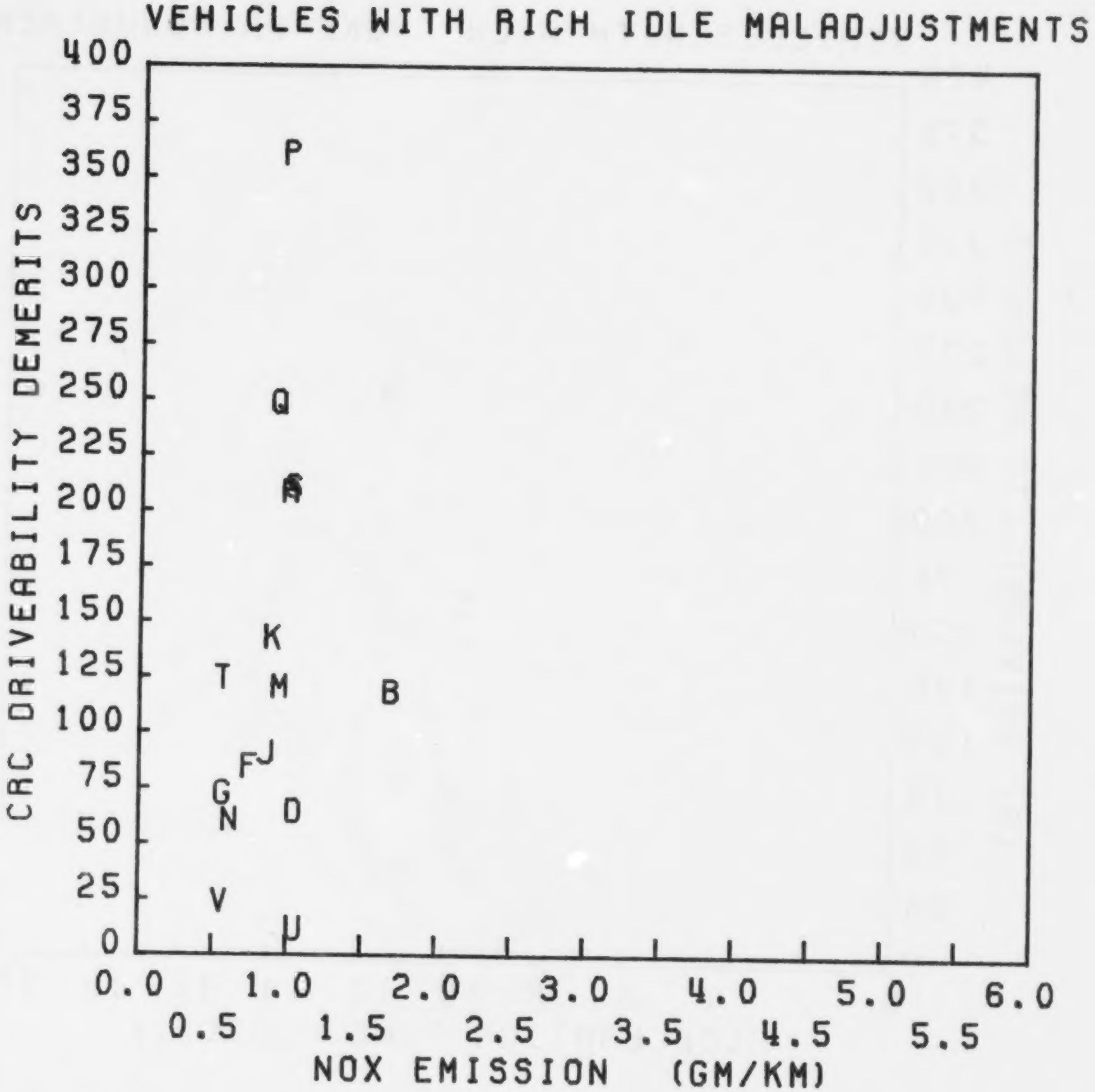

VEHICLES WITH RICH IDLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
ACCELERATION TIME (SECS.)
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
P
Q
S
R
K
T
B
M
J
F
G
D
N
V
U

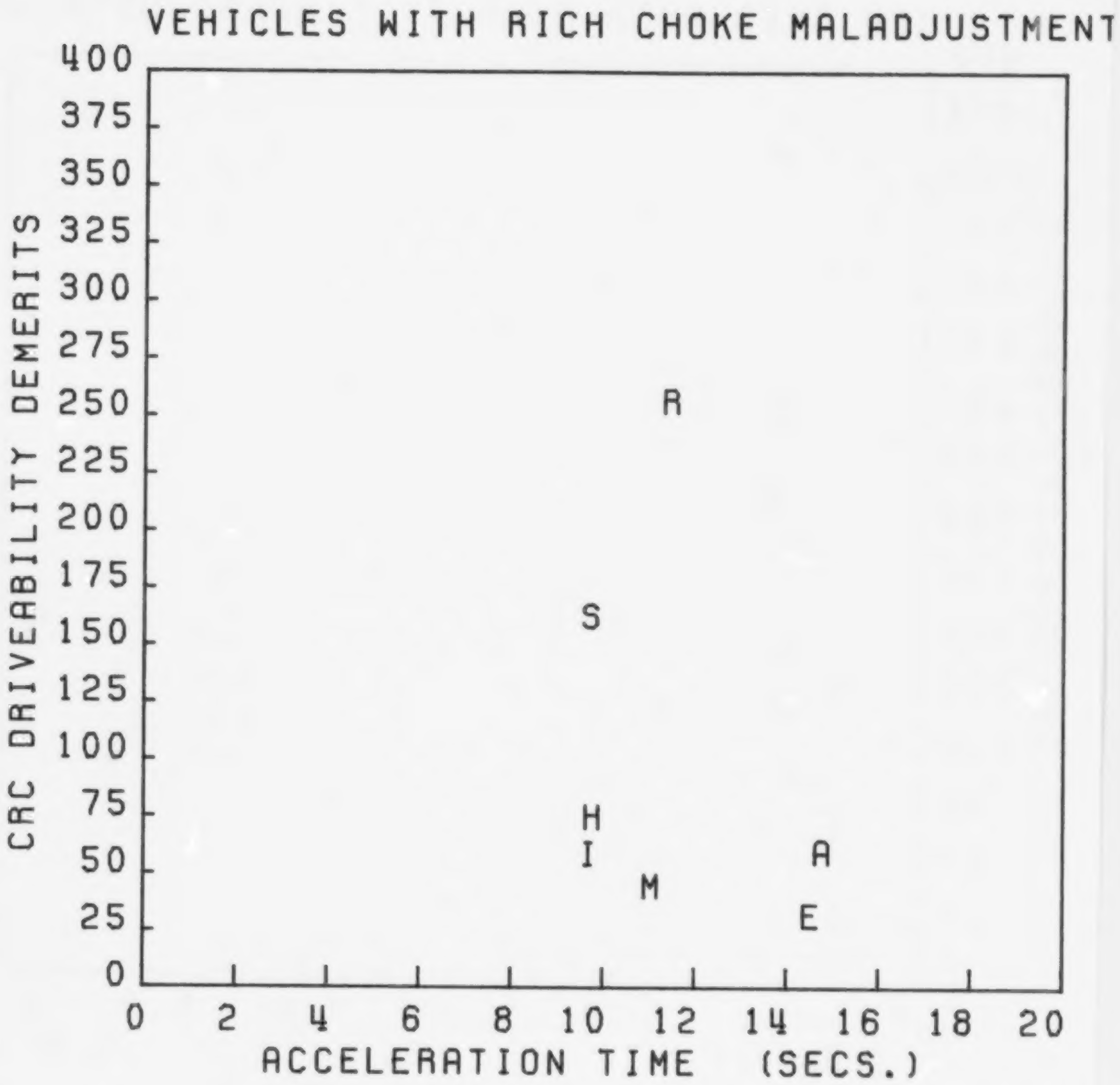

VEHICLES WITH RICH IDLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
FTP FUEL CONSUMPTION (L/1000KM)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
P
Q
A
K
B
M
T
J
F
G
D
N
V
U

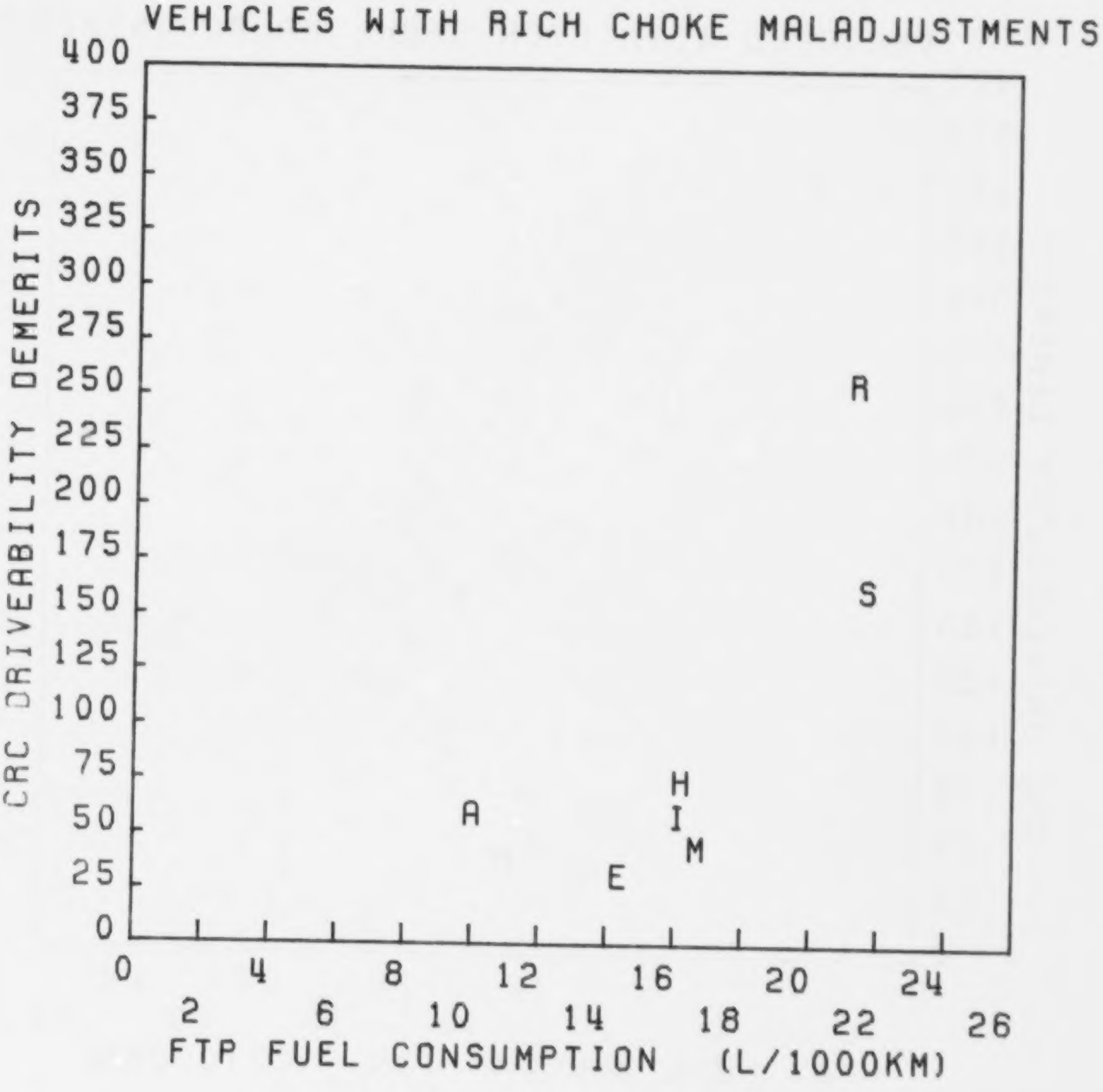

VEHICLES WITH RICH IDLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
HFET FUEL CONSUMPTION (L/1000KM)
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
2
4
6
8
10
12
14
16
18
20
22
24
26
P
Q
S
R
K
BM
T
J
F
G
D
N
V
U

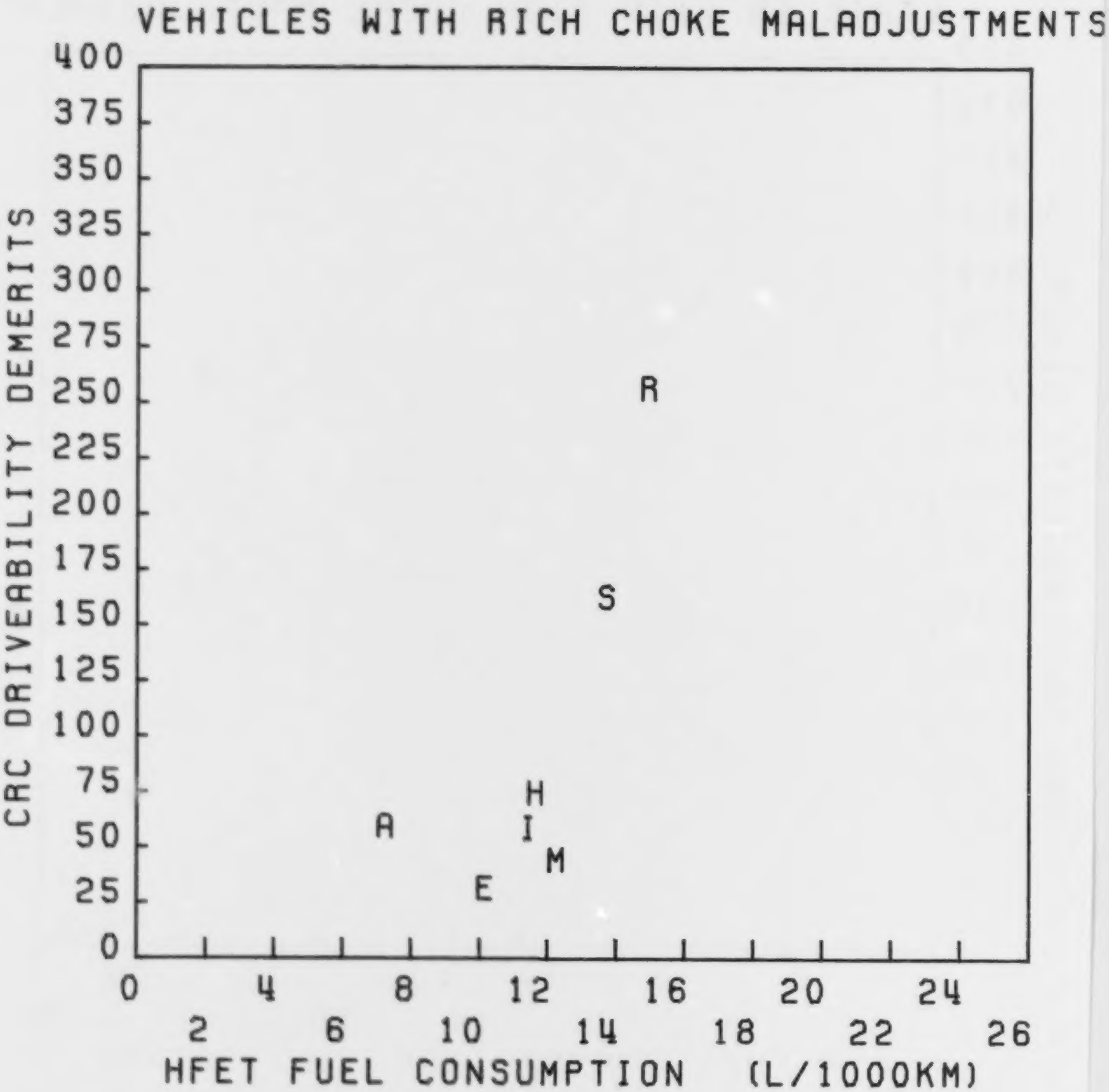

VEHICLES WITH RICH IDLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
HC EMISSION (GM/KM)
0.0
0.4
0.8
1.2
1.6
2.0
P
Q
R
S
K
T
M
B
J
F
G
N
D
V
U

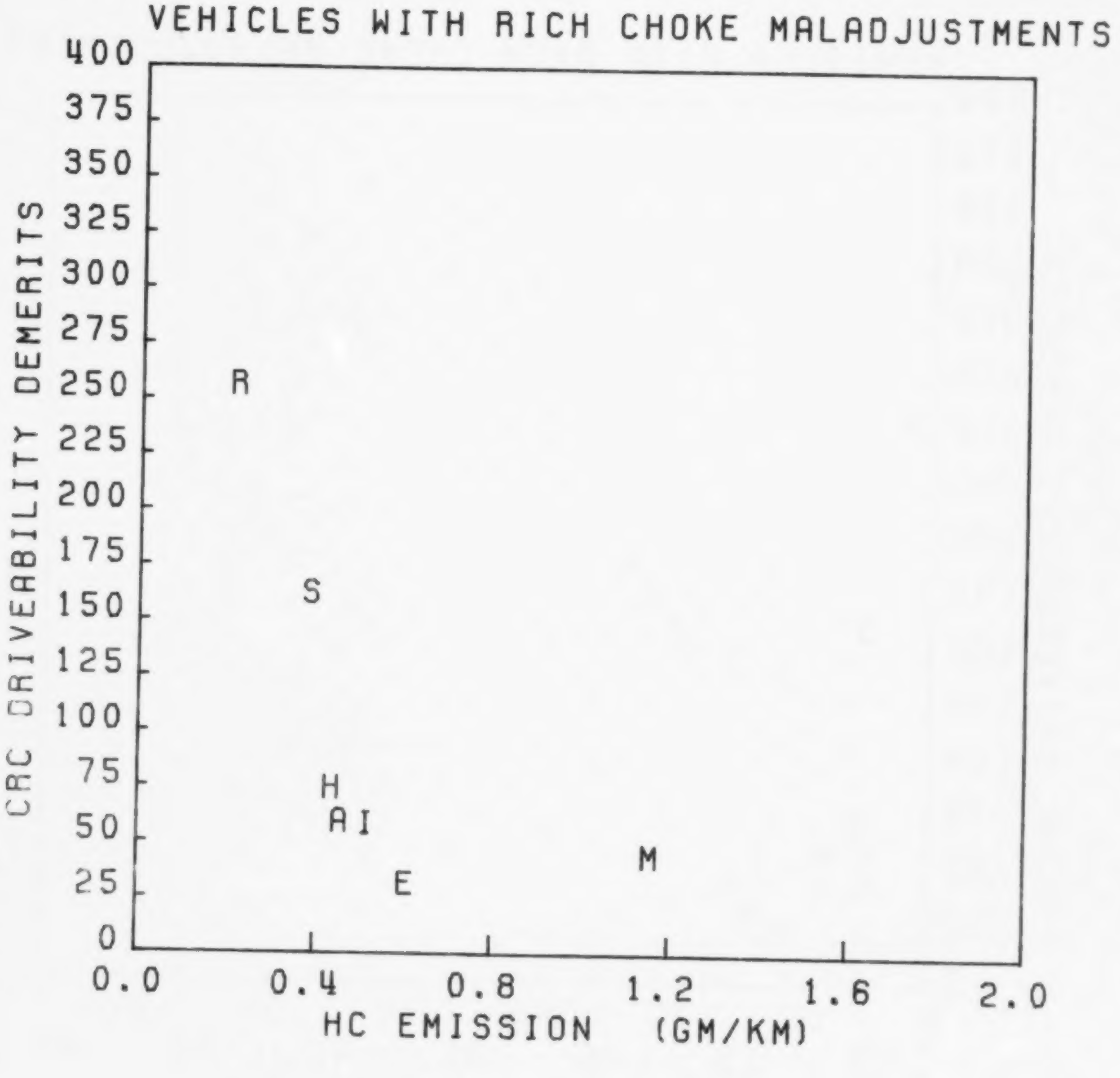

VEHICLES WITH RICH IDLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
P
Q
S
R
K
T
M
B
J
F
G
D
N
V
U
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

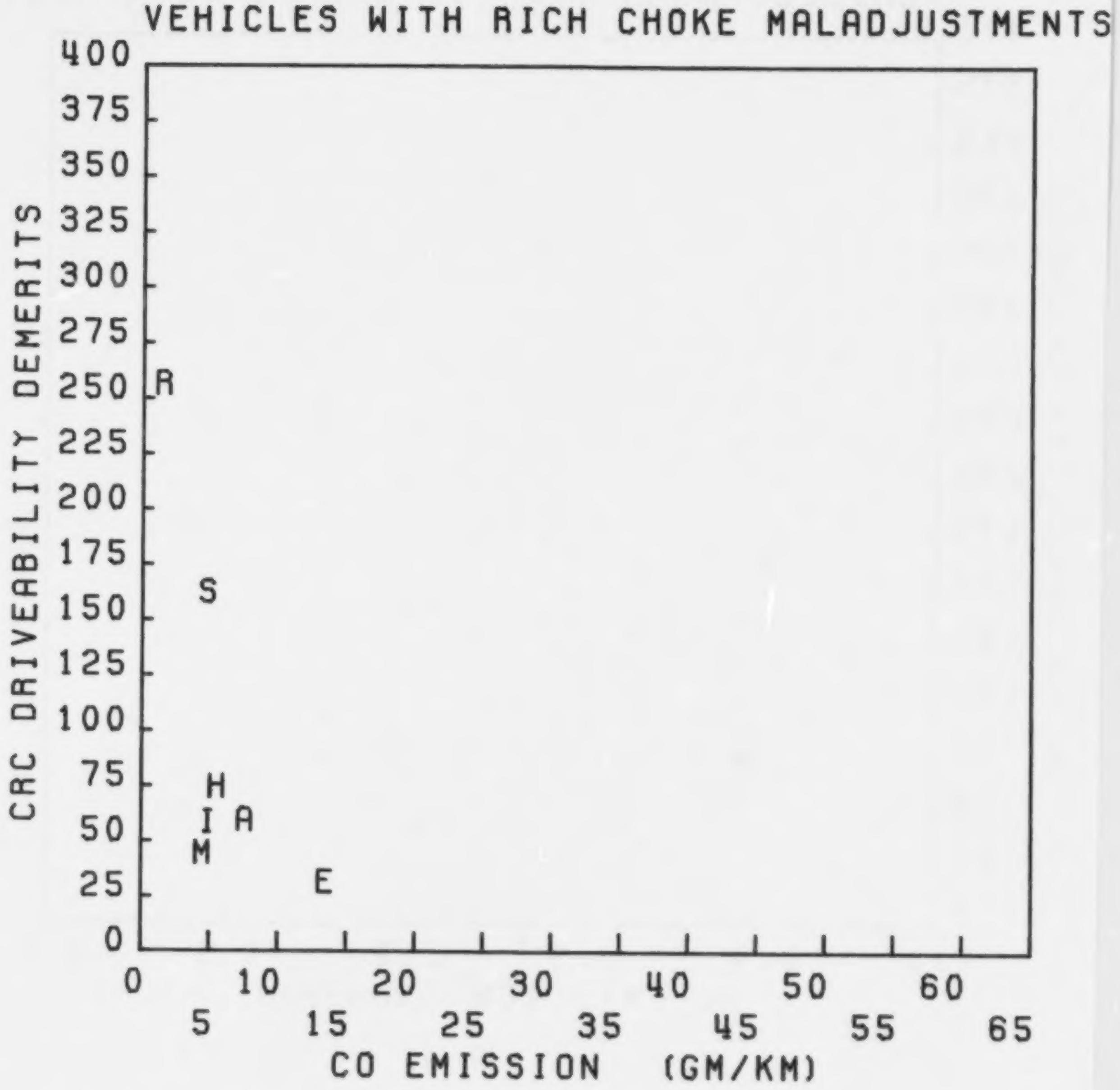

VEHICLES WITH RICH IDLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
P
Q
S
A
K
T
M
B
J
F
G
N
D
V
U
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

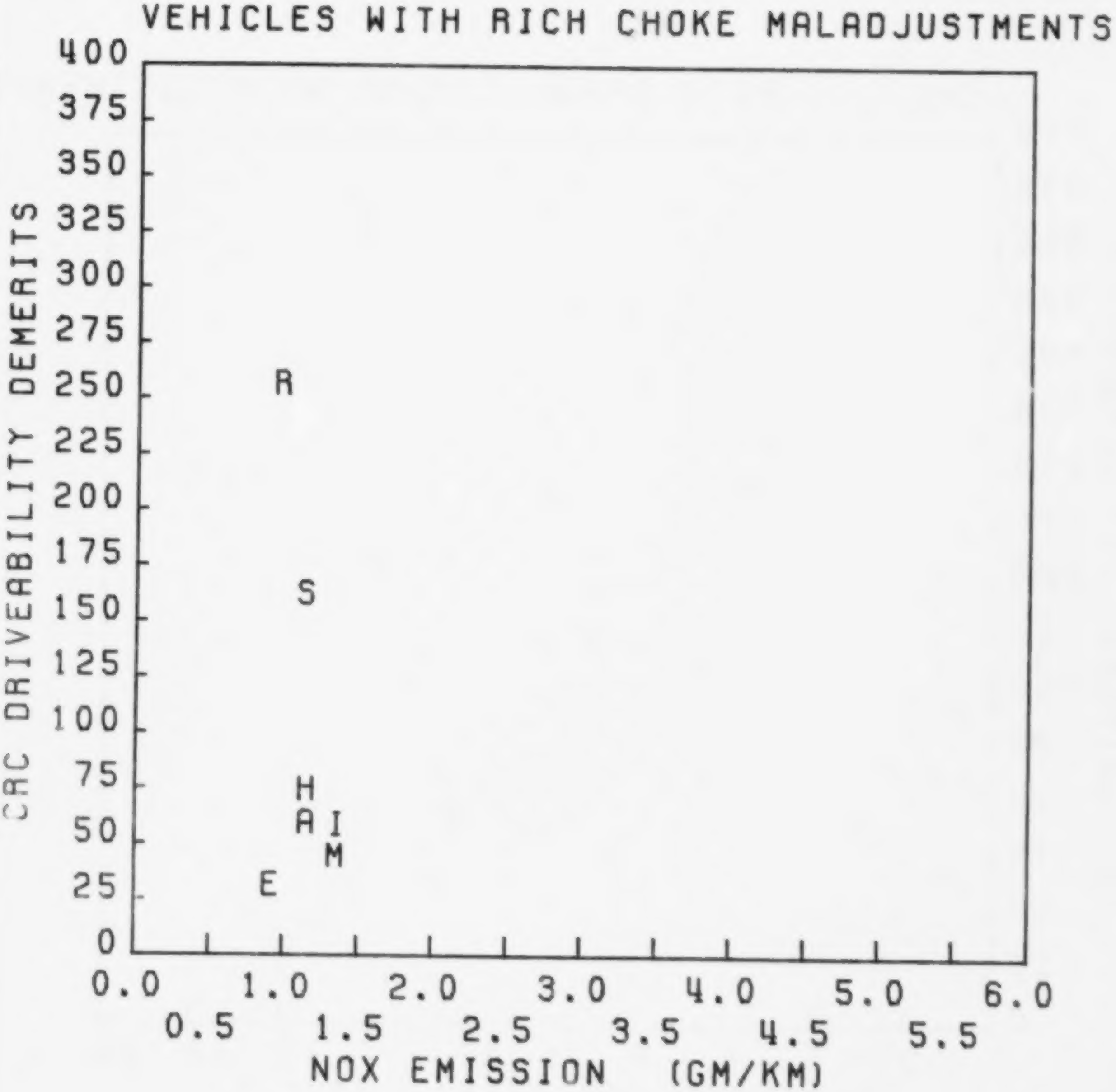

VEHICLES WITH RICH CHOKE MALADJUSTMENT
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)
R
S
H
I
M
A
E

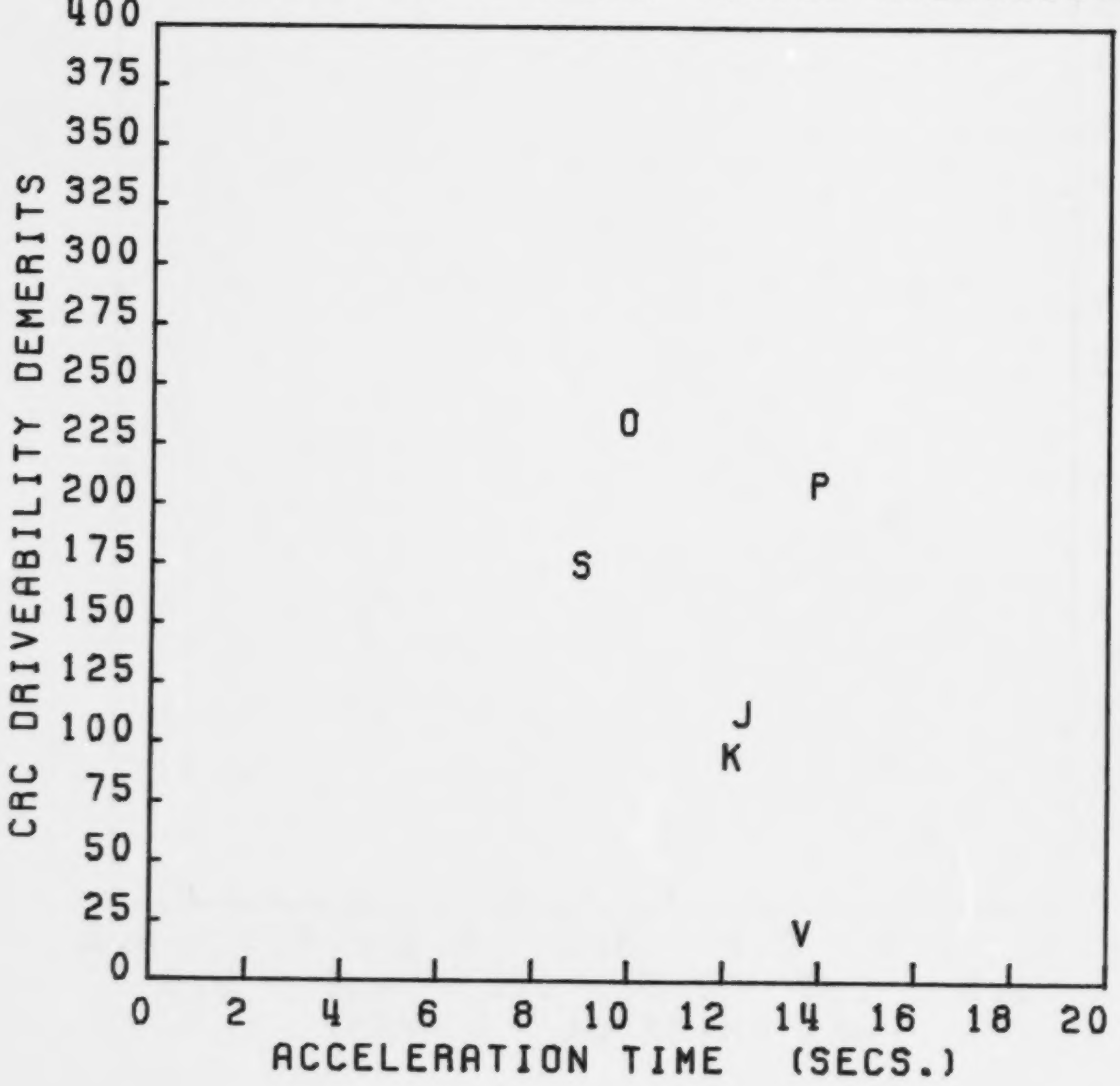

VEHICLES WITH RICH CHOKE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
R
S
H
I
M
A
E
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)


VEHICLES WITH RICH CHOKE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
HFET FUEL CONSUMPTION (L/1000KM)
0
4
8
12
16
20
24
2
6
10
14
18
22
26
R
S
H
A
I
M
E

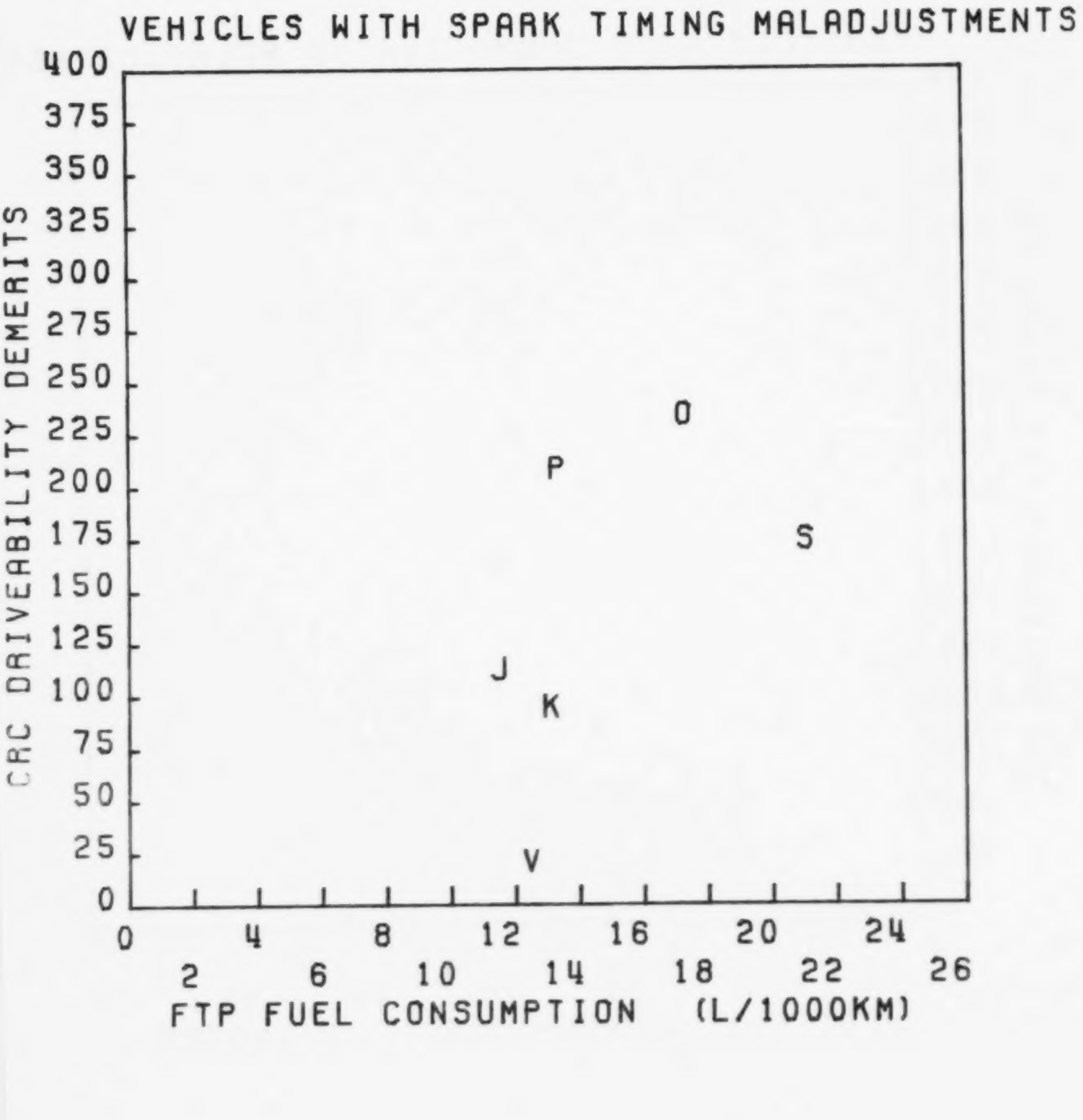

VEHICLES WITH RICH CHOKE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
R
S
H
A
I
E
M
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)

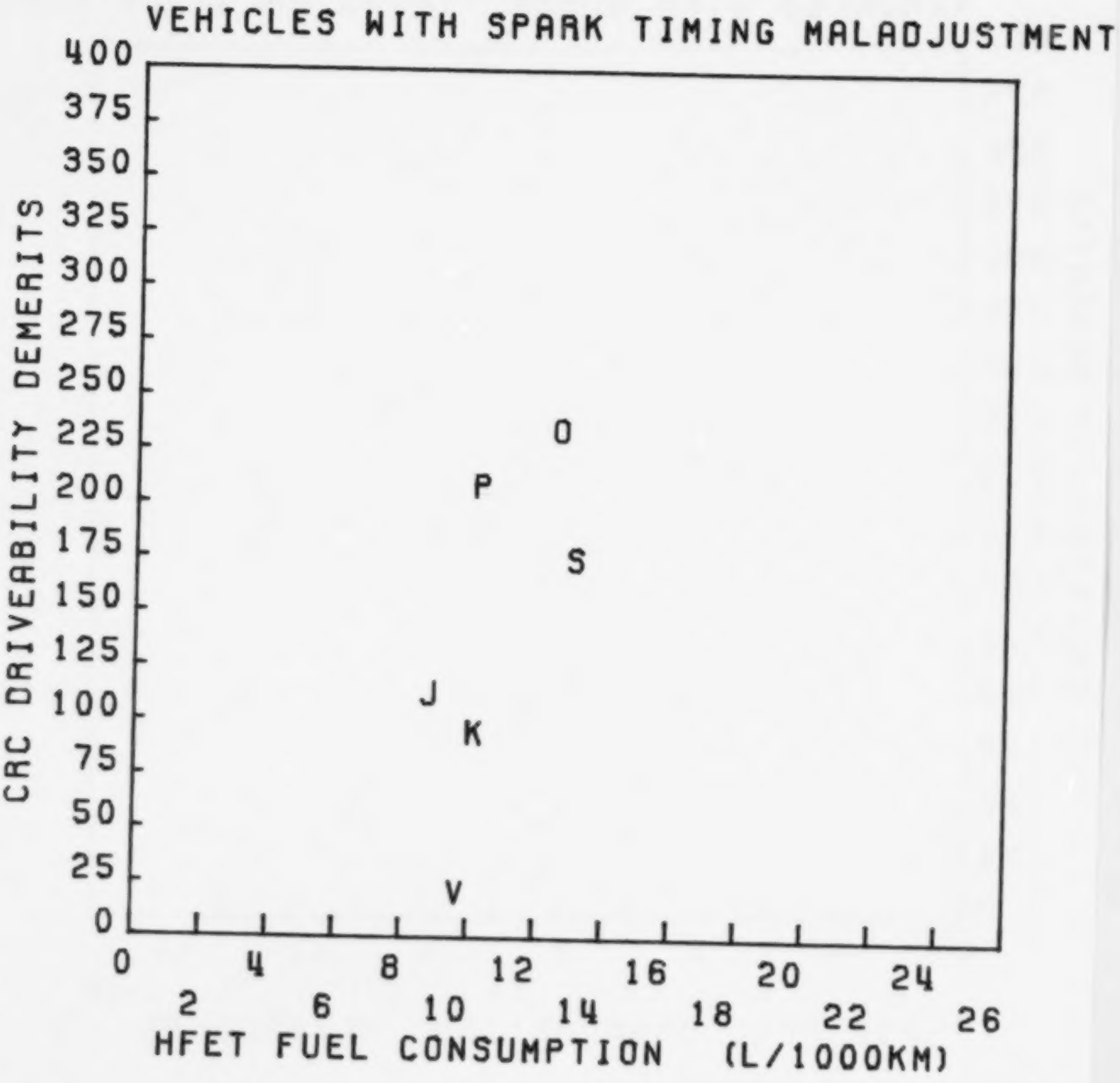

VEHICLES WITH RICH CHOKE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
R
S
H
I
A
M
E
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

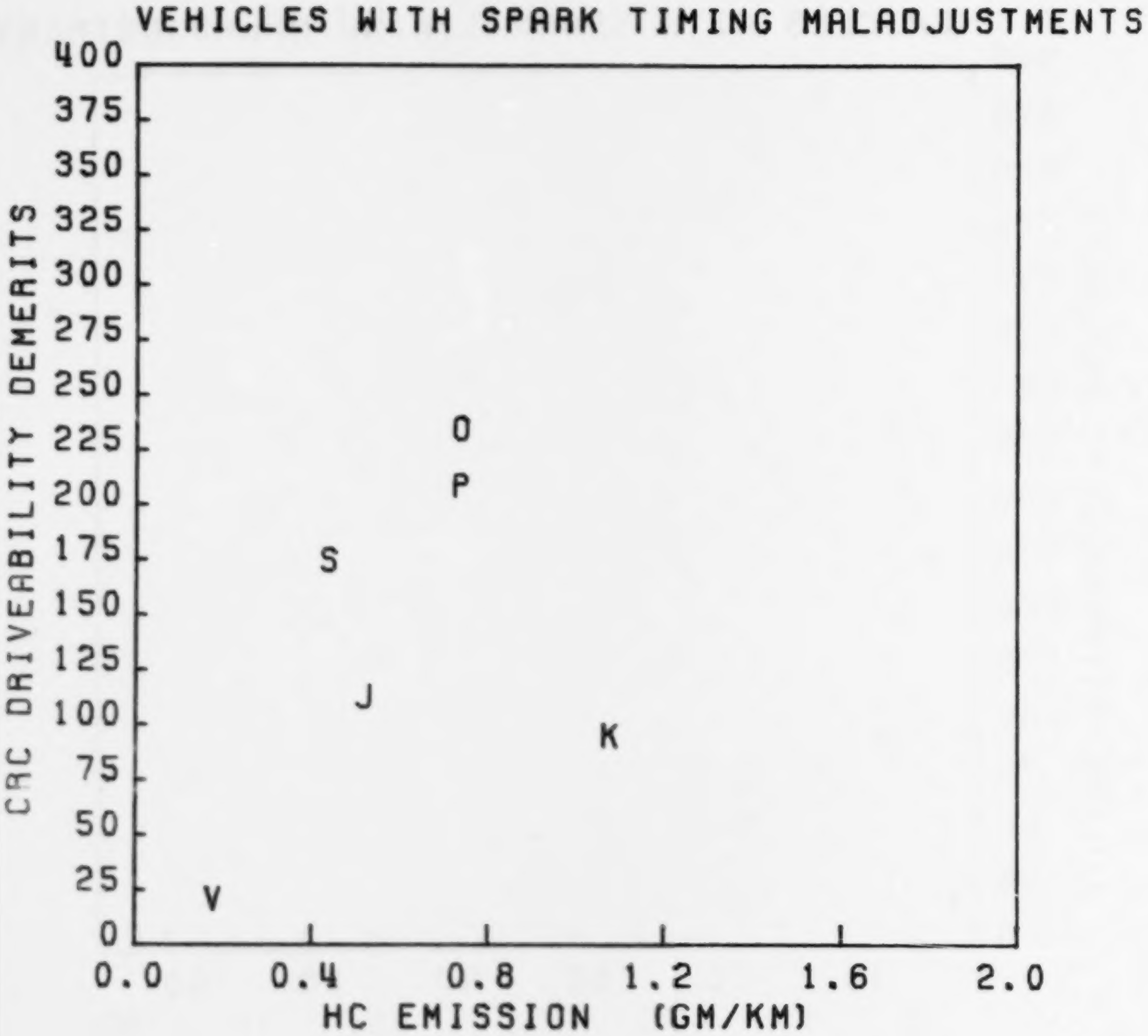

VEHICLES WITH RICH CHOKE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
R
S
H
A
I
M
E
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

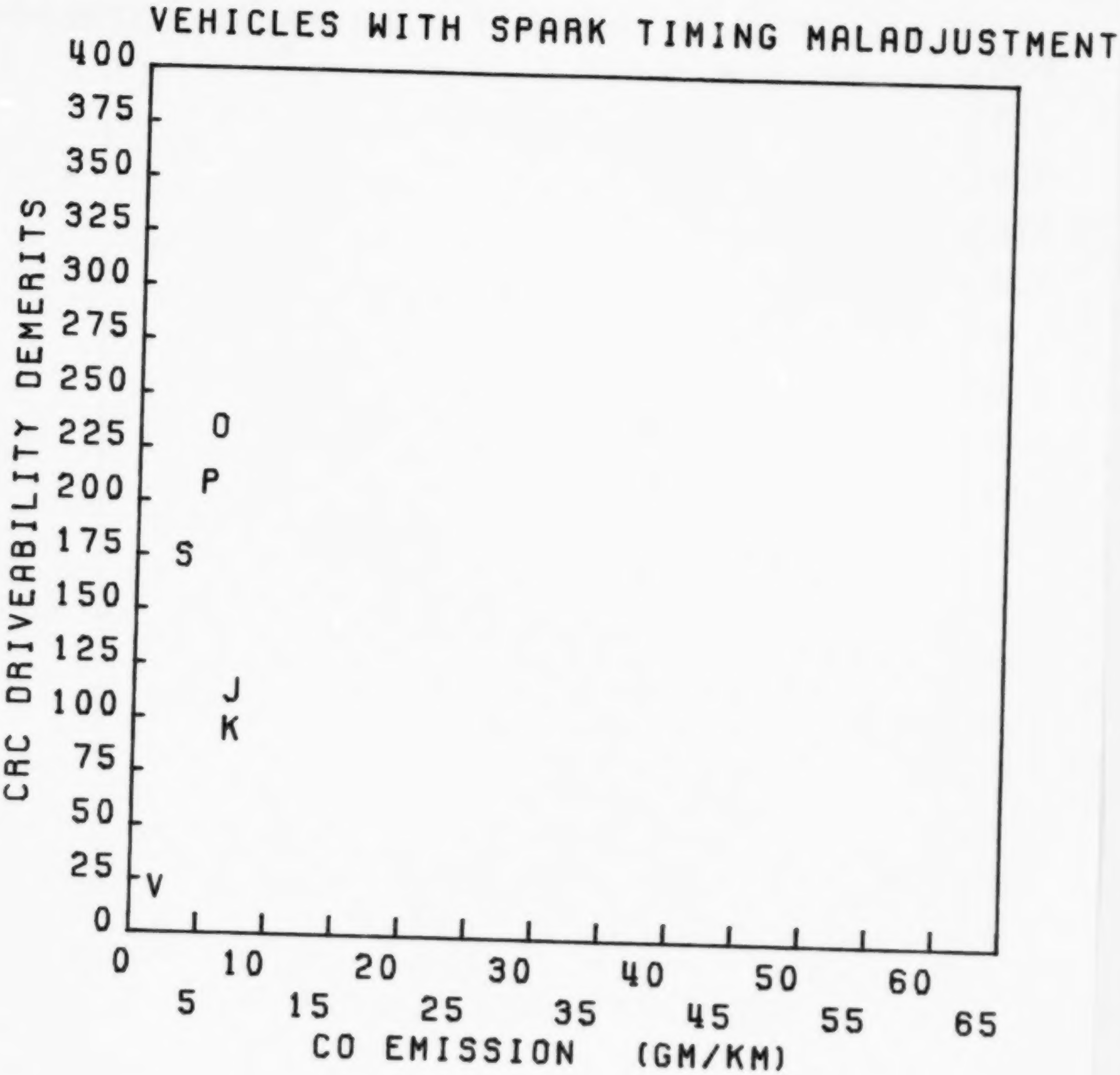


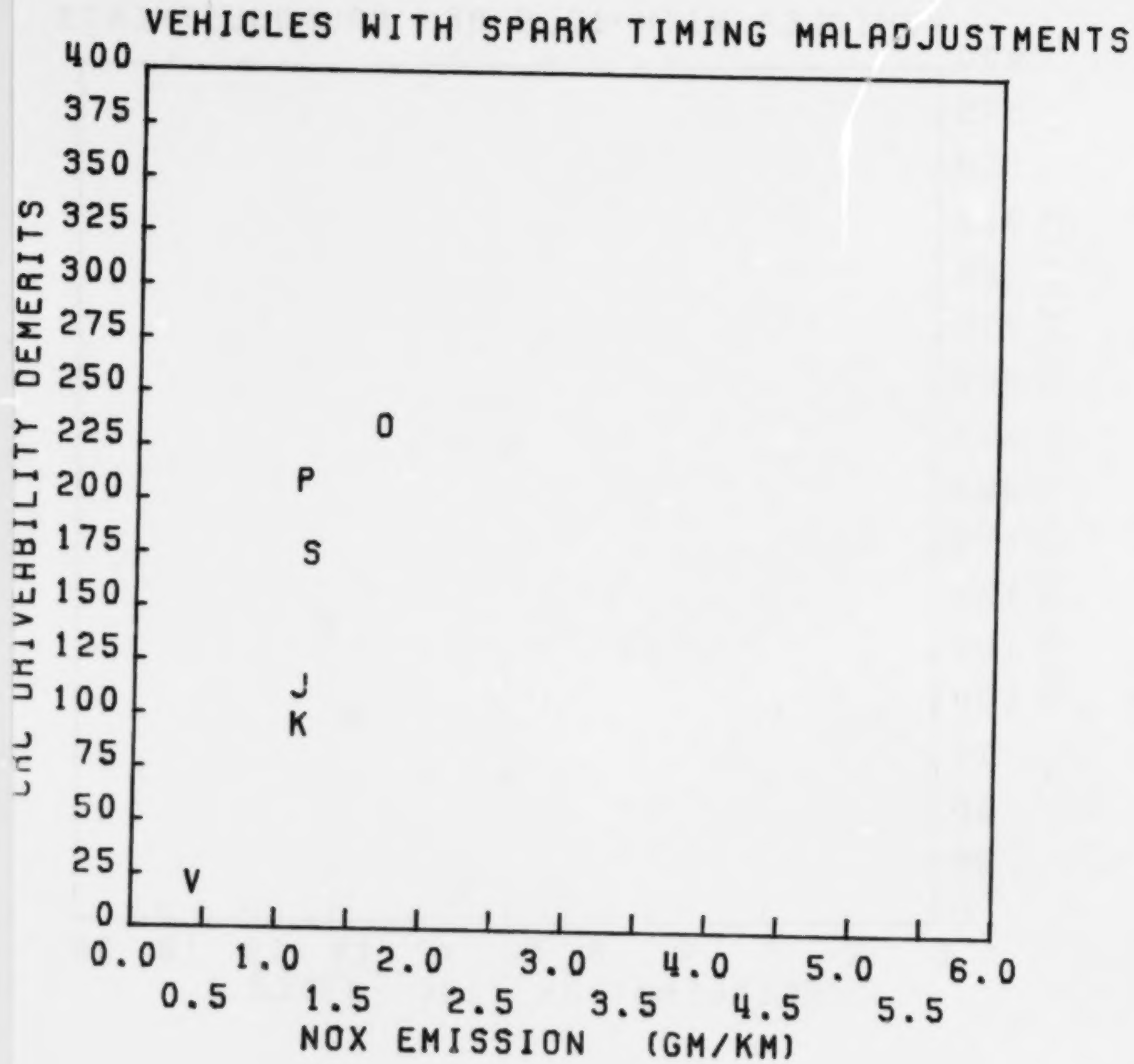
VEHICLES WITH SPARK TIMING MALADJUSTMENTS

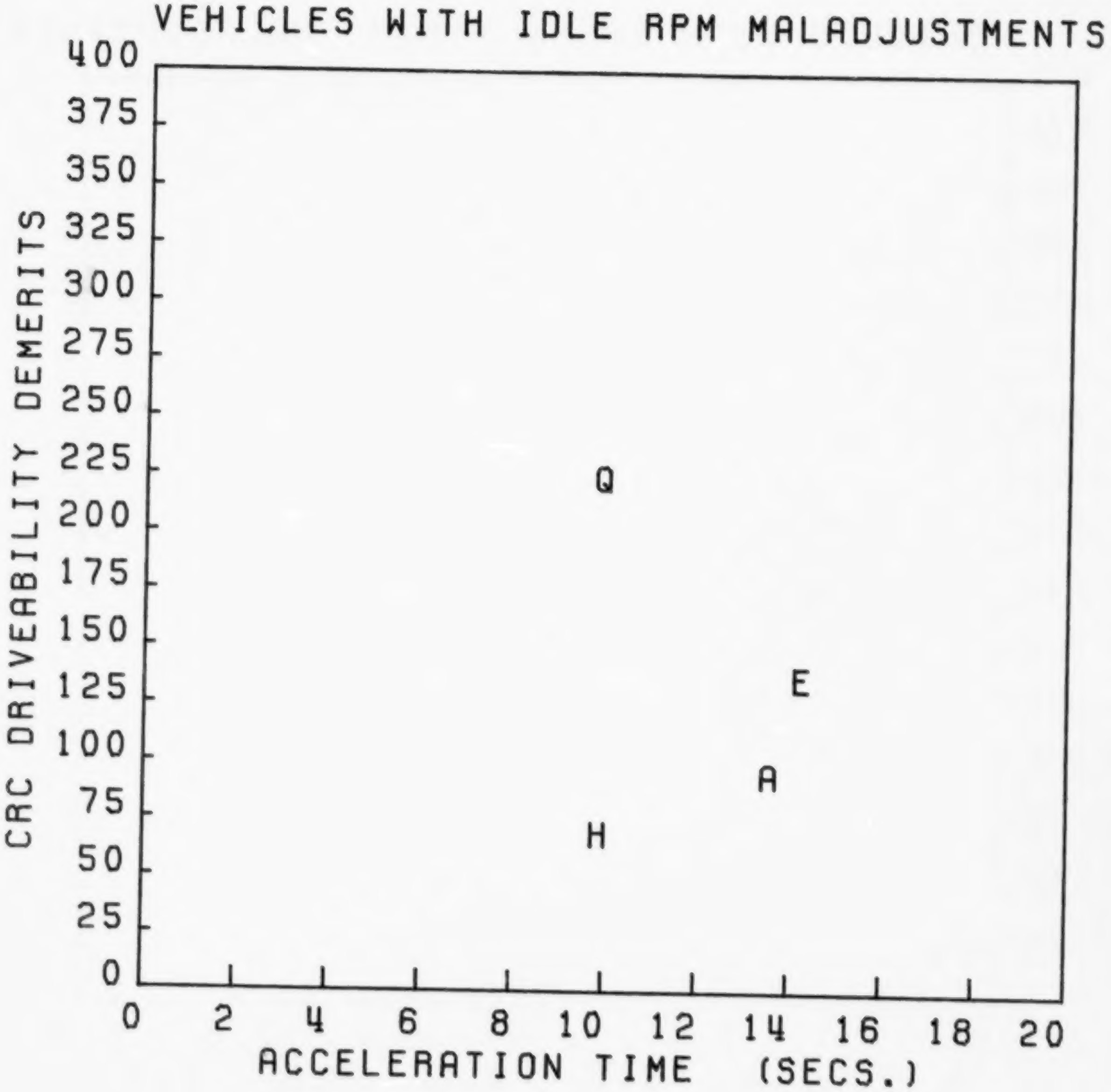

VEHICLES WITH SPARK TIMING MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
FTP FUEL CONSUMPTION (L/1000KM)
O
P
S
J
K
V

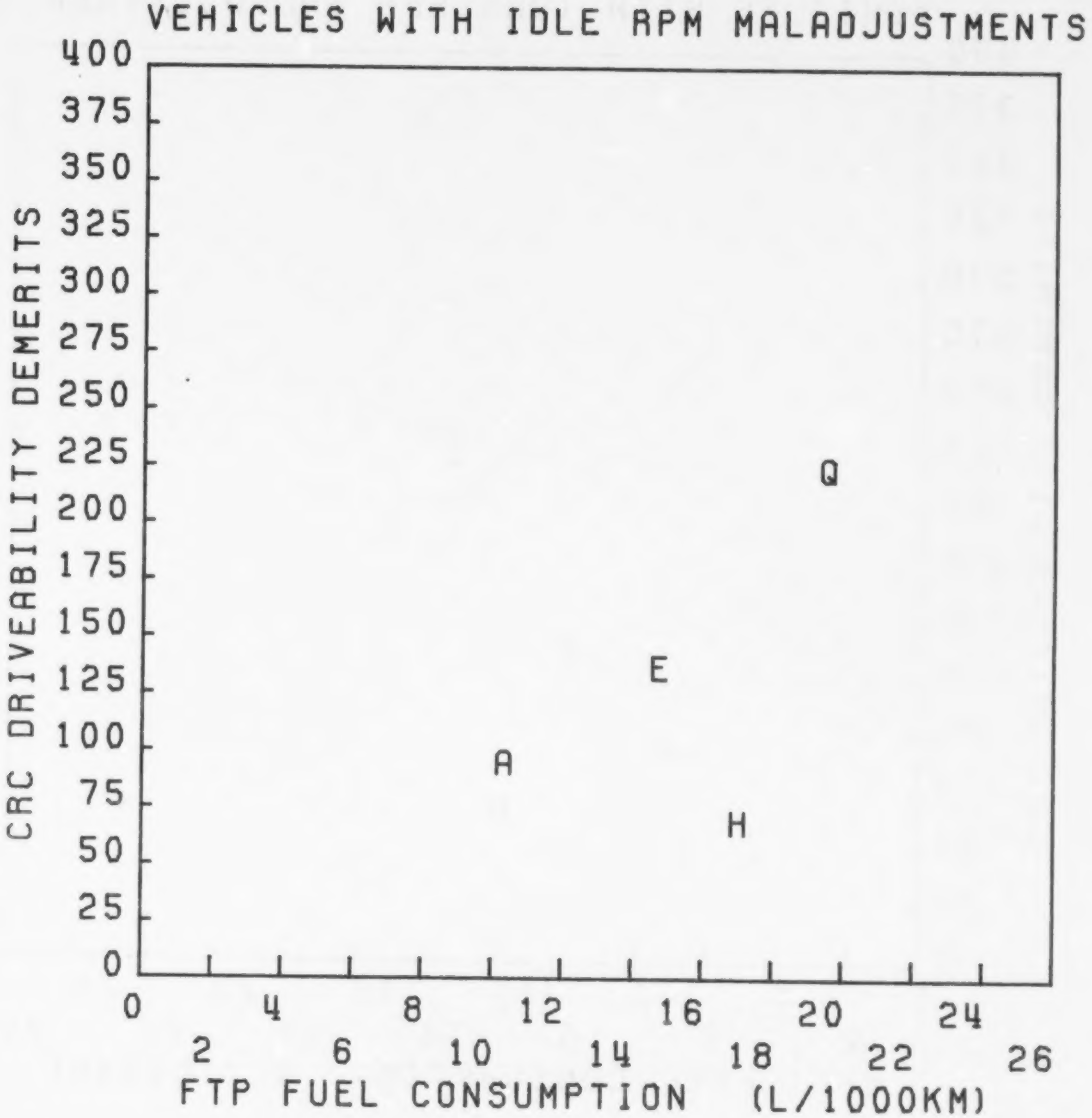

VEHICLES WITH SPARK TIMING MALADJUSTMENT
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
O
P
S
J
K
V
0
2
4
6
8
10
12
14
16
18
20
22
24
26
HFET FUEL CONSUMPTION (L/1000KM)

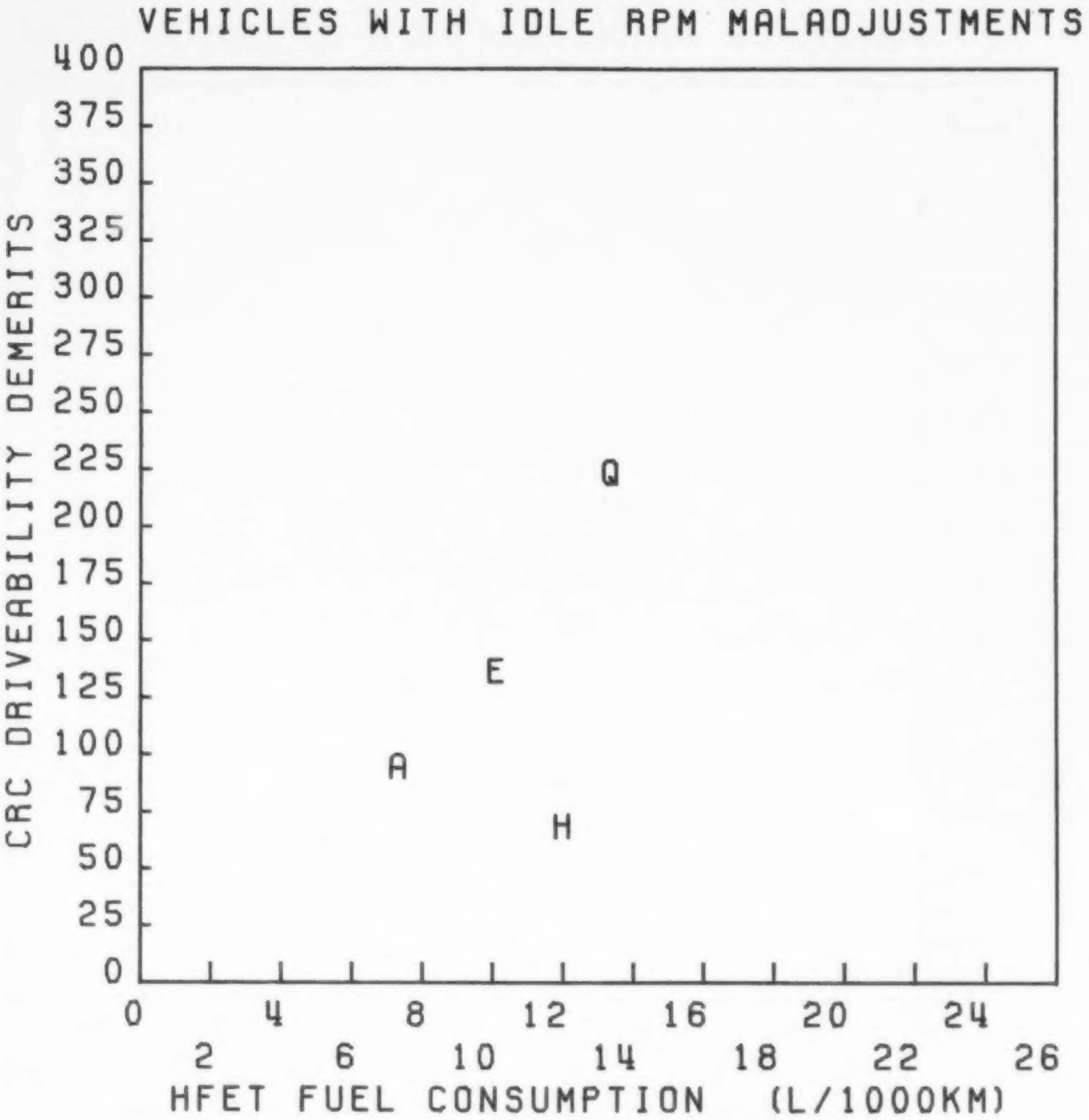

VEHICLES WITH SPARK TIMING MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
O
P
S
J
K
V
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)

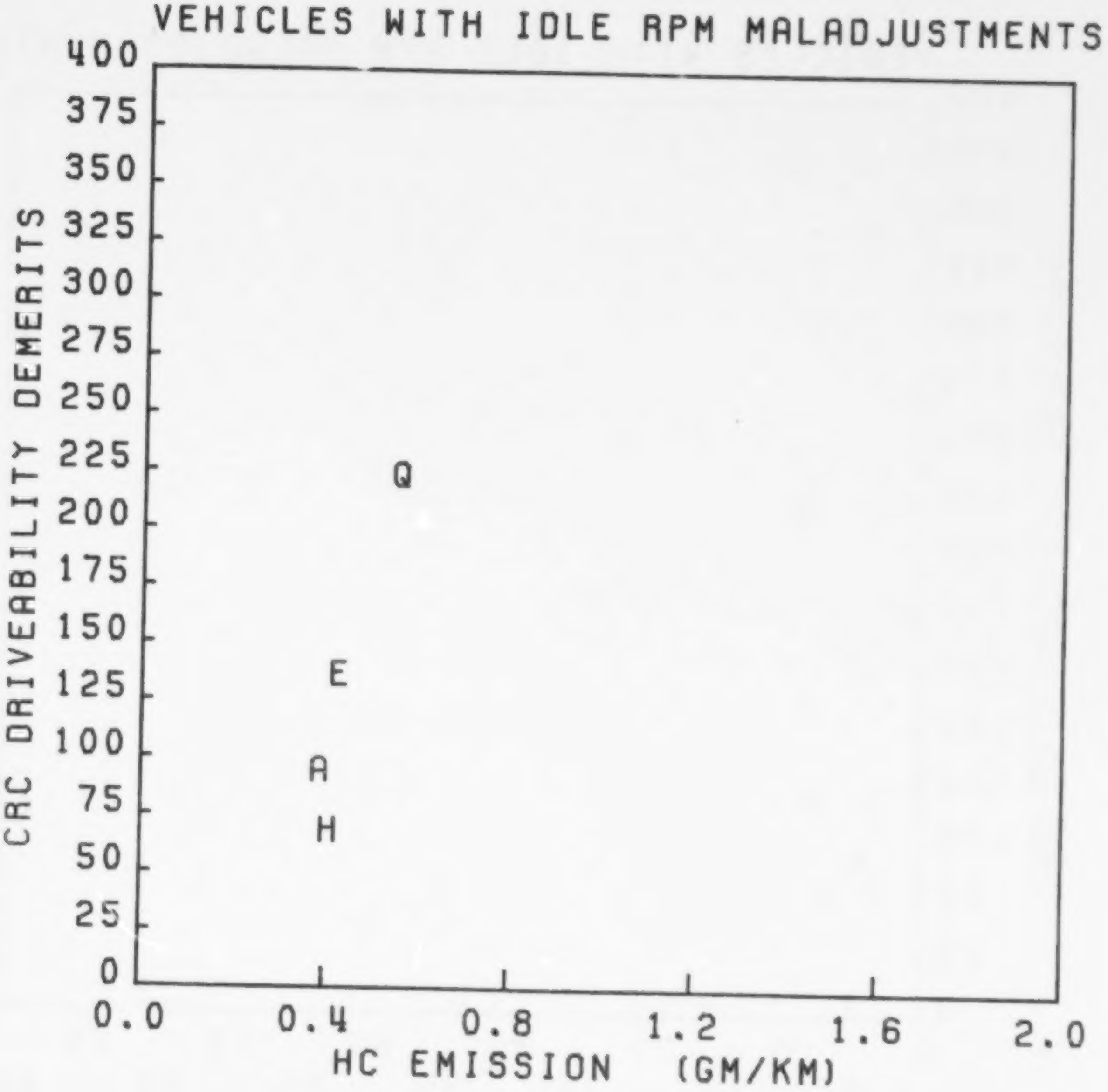

VEHICLES WITH SPARK TIMING MALADJUSTMENT
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
O
P
S
J
K
V
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

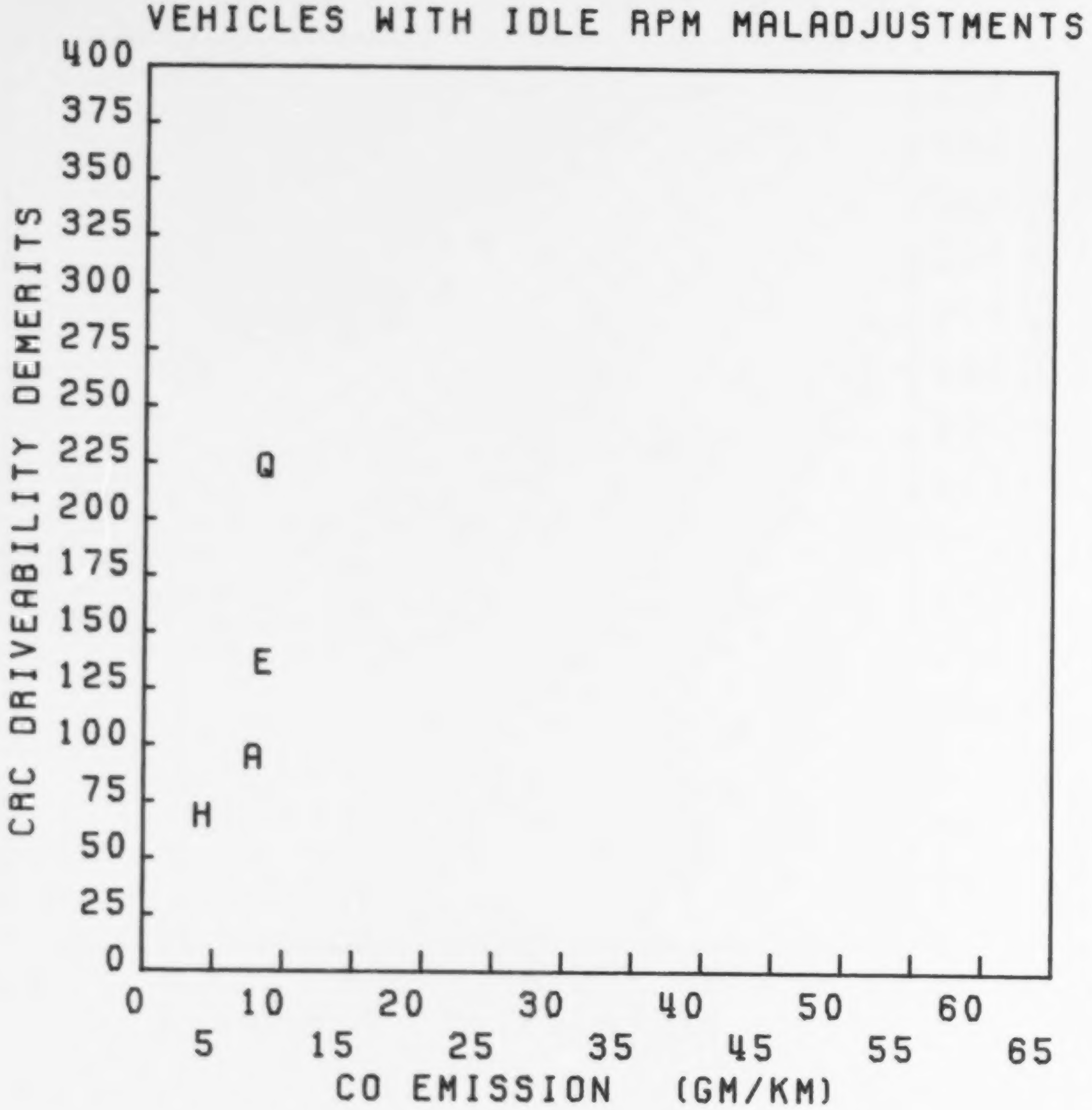

VEHICLES WITH SPARK TIMING MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
O
P
S
J
K
V
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
NOX EMISSION (GM/KM)

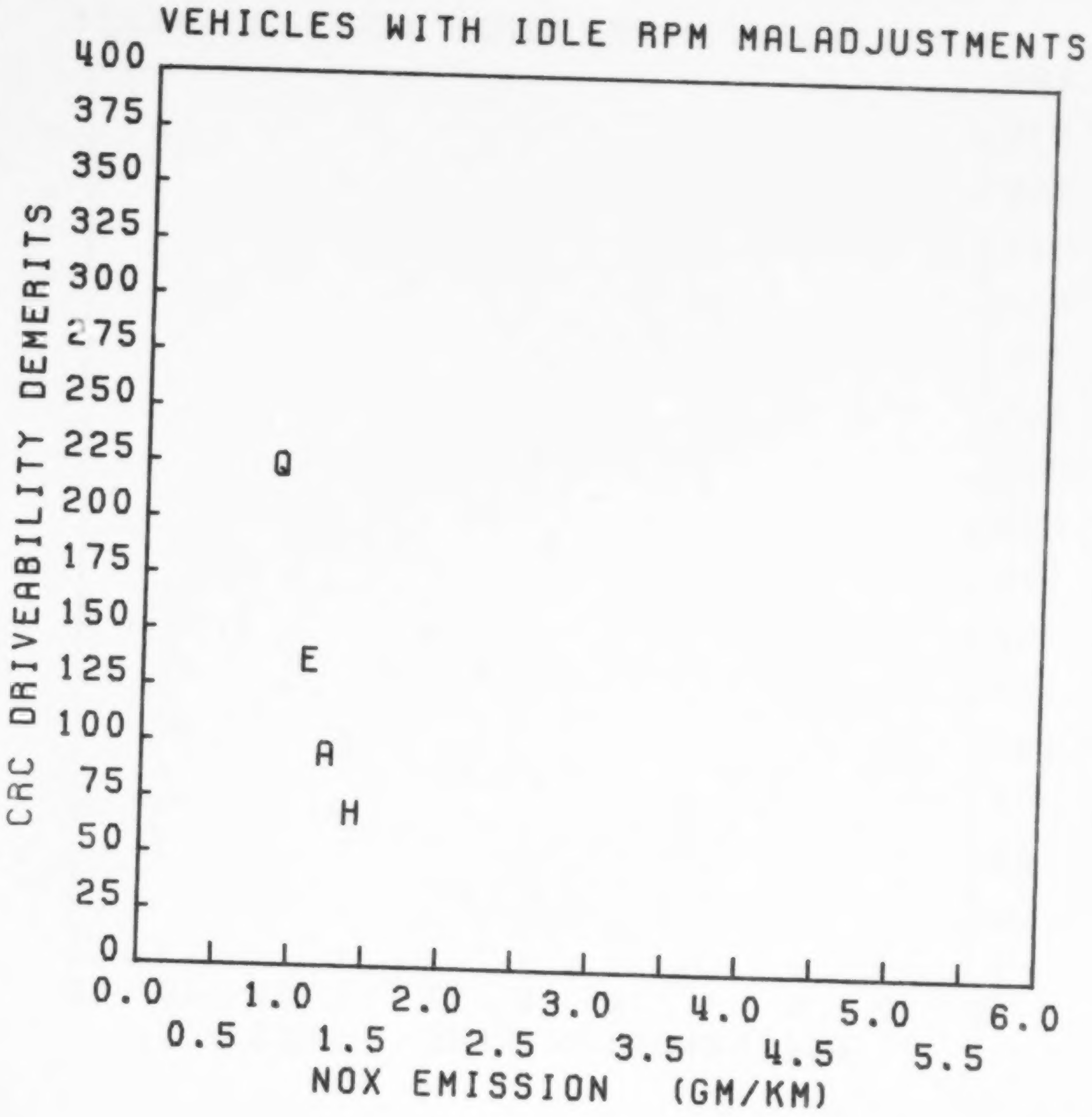

VEHICLES WITH IDLE RPM MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
20
ACCELERATION TIME (SECS.)
Q
E
A
H

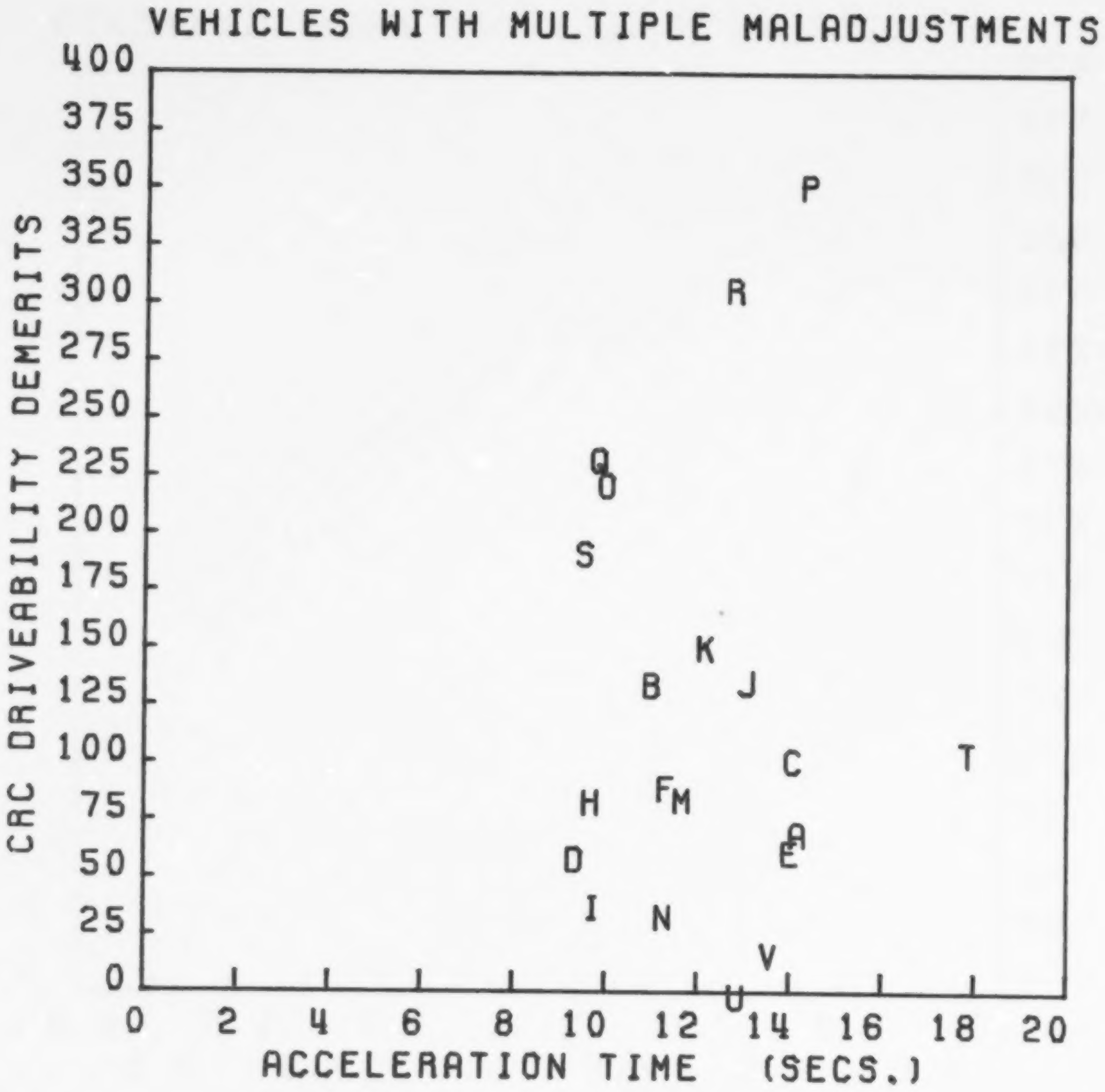

VEHICLES WITH IDLE RPM MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
Q
E
A
H
0
4
8
12
16
20
24
2
6
10
14
18
22
26
FTP FUEL CONSUMPTION (L/1000KM)

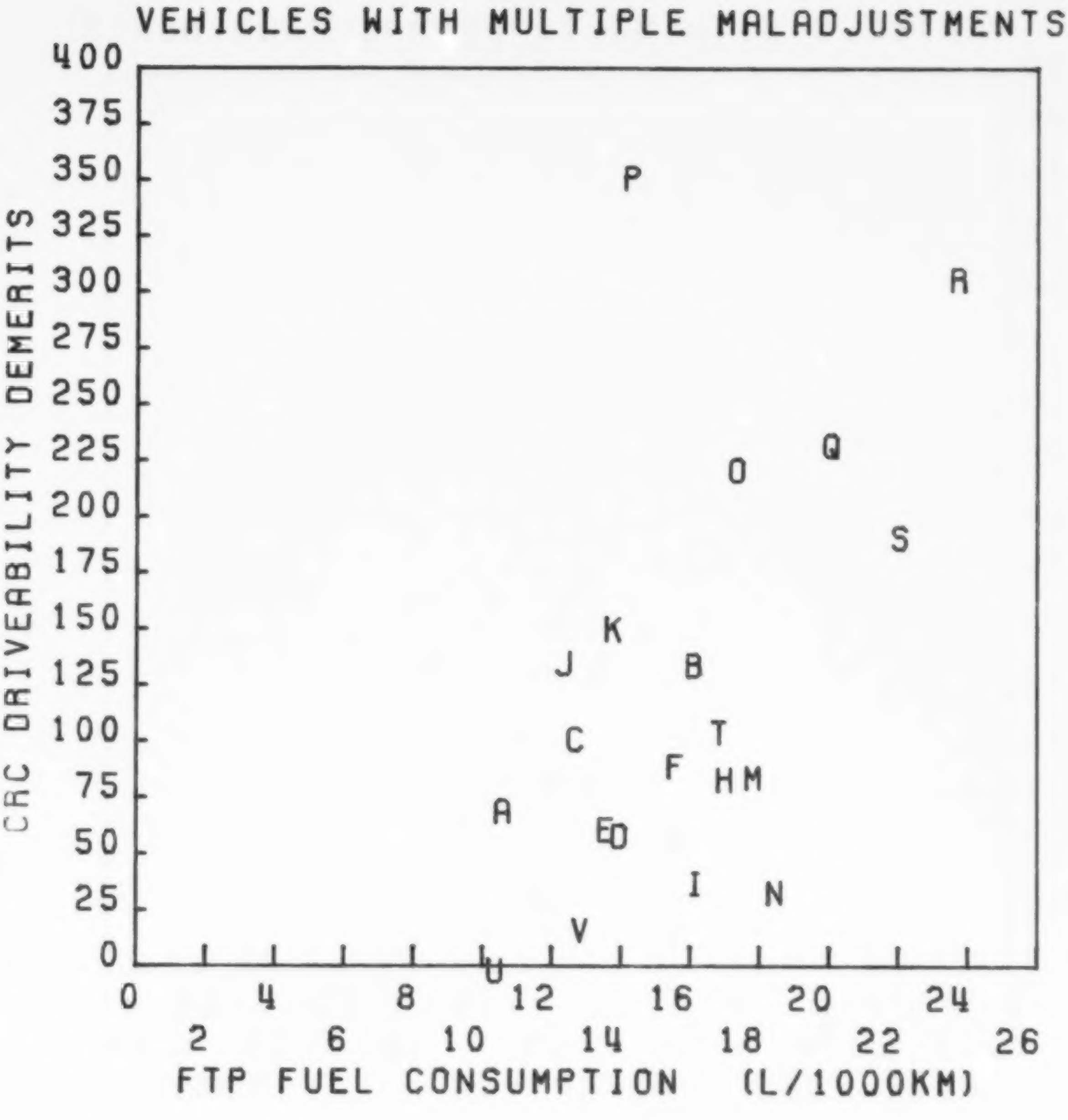

VEHICLES WITH IDLE RPM MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
Q
E
A
H
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)

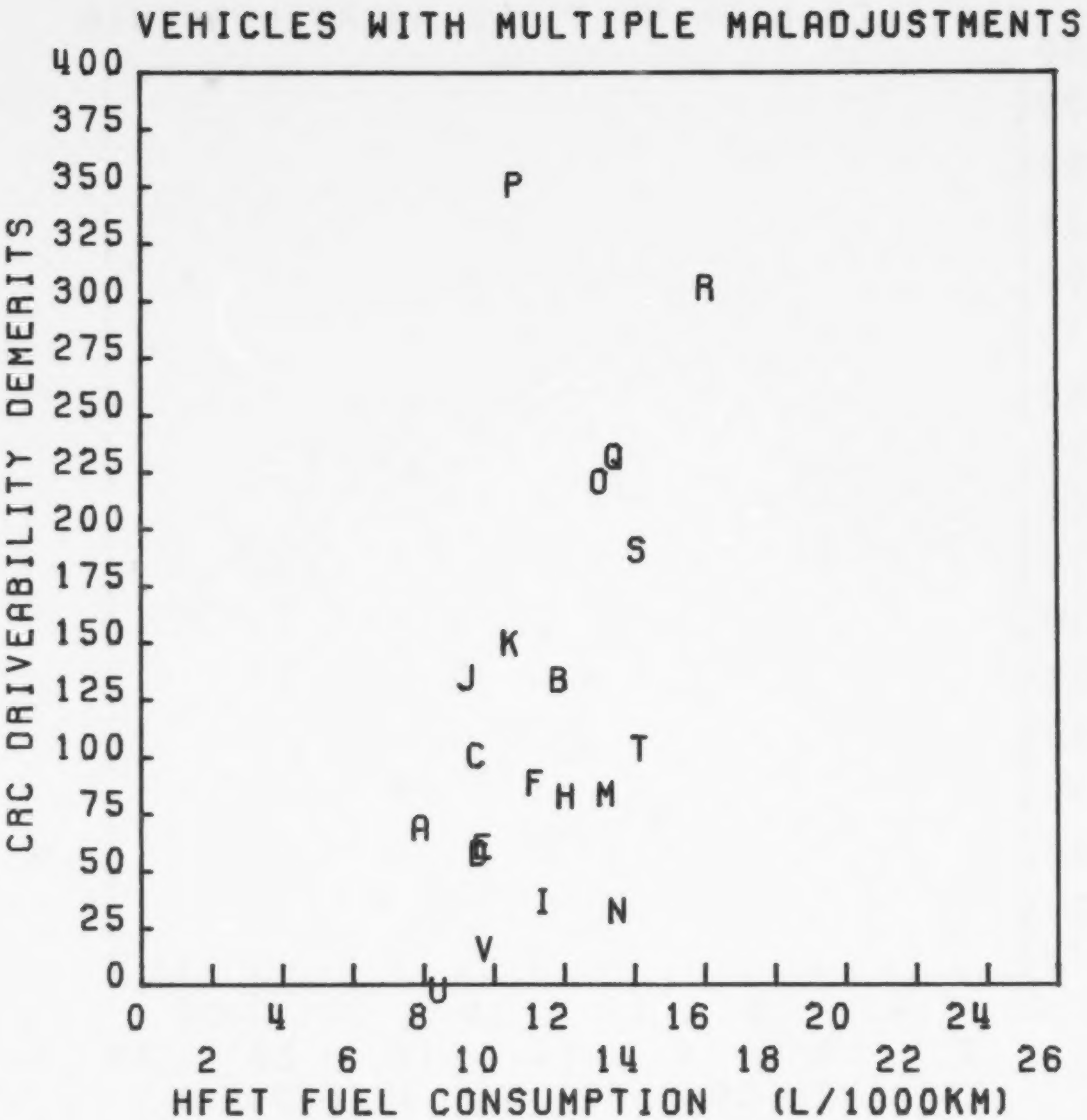

VEHICLES WITH IDLE RPM MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
HC EMISSION (GM/KM)
Q
E
A
H

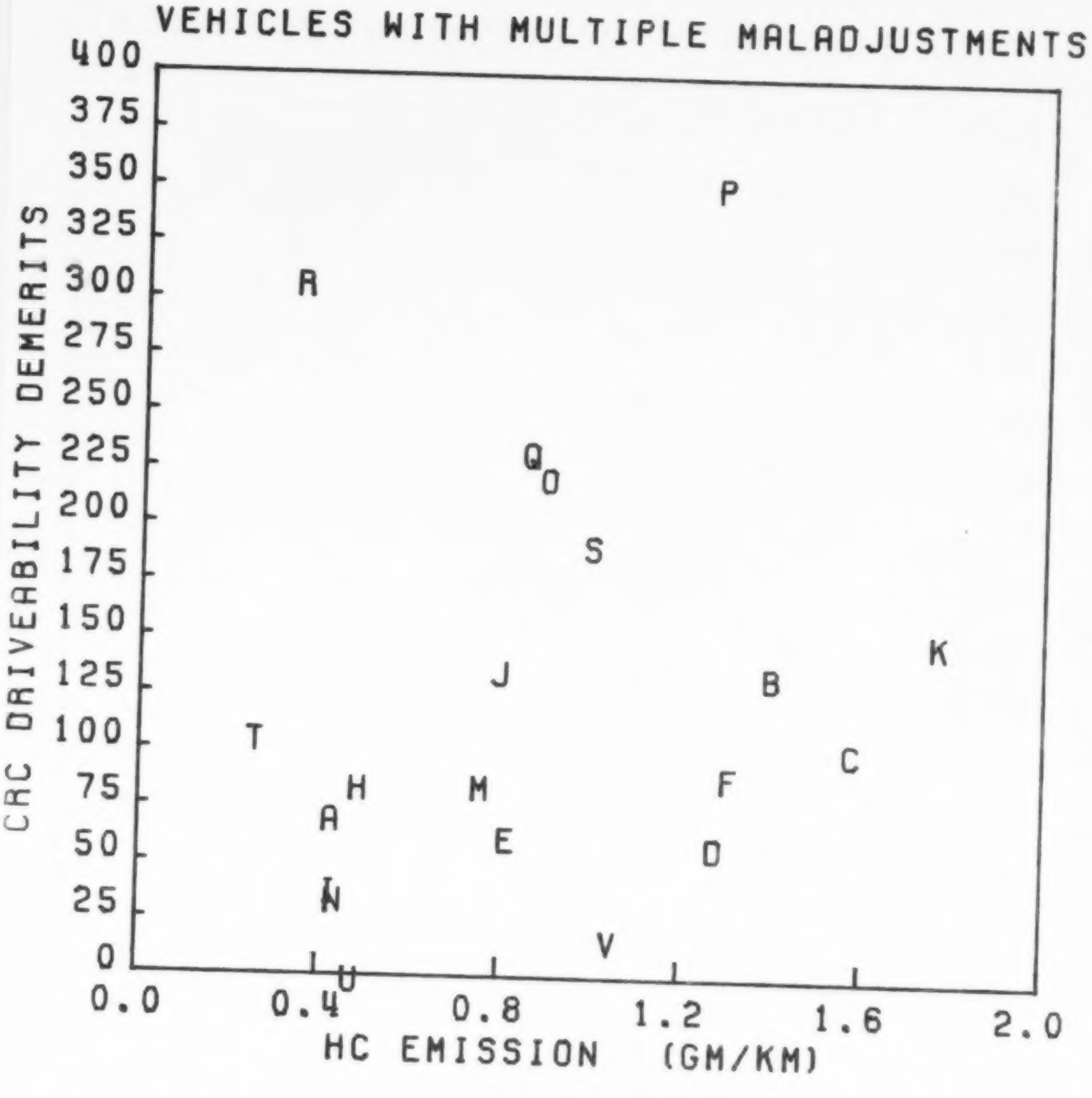

VEHICLES WITH IDLE RPM MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
Q
E
A
H
0
10
20
30
40
50
60
5
15
25
35
45
55
65
CO EMISSION (GM/KM)

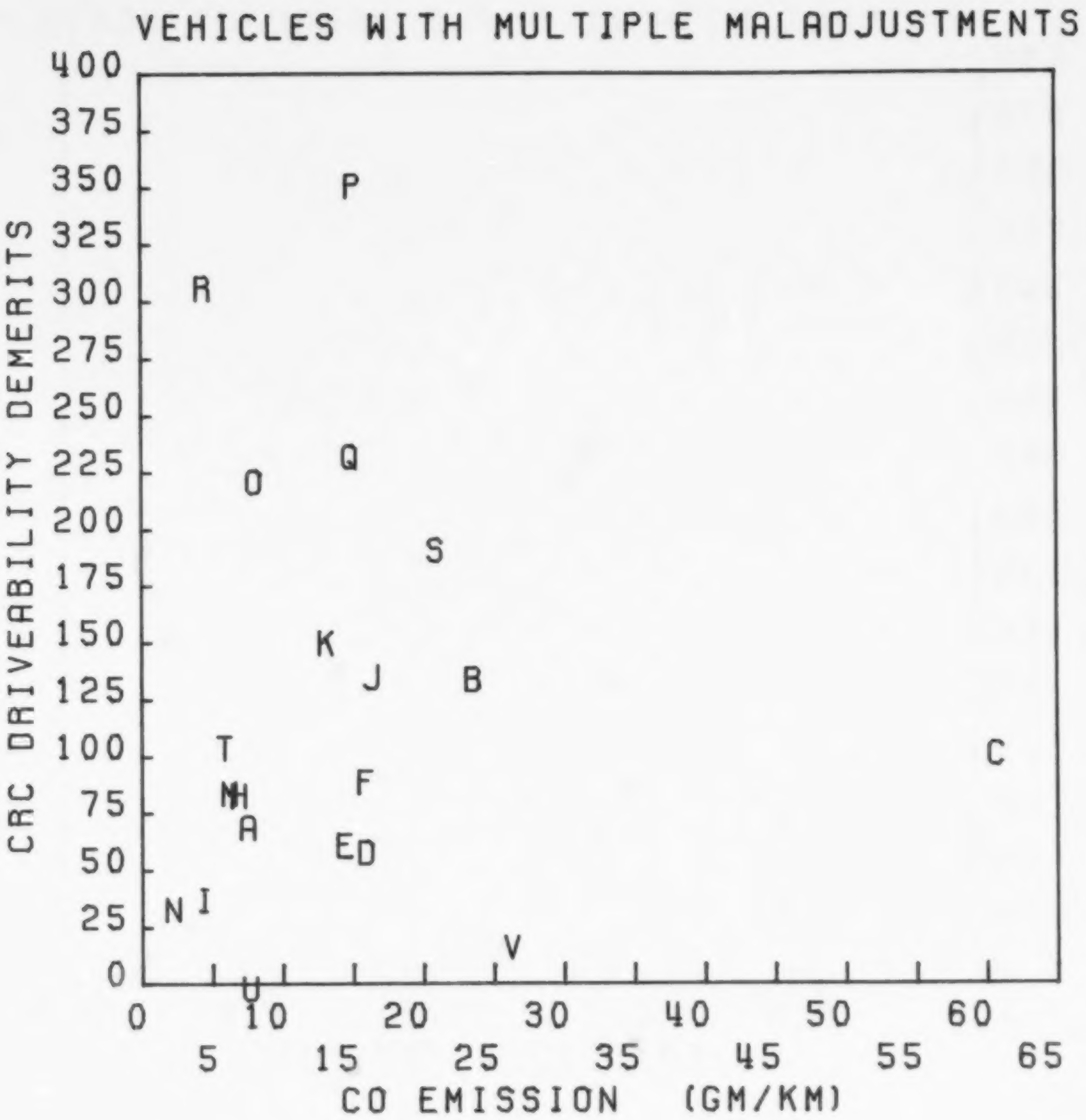

VEHICLES WITH IDLE RPM MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
NOX EMISSION (GM/KM)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Q
E
A
H

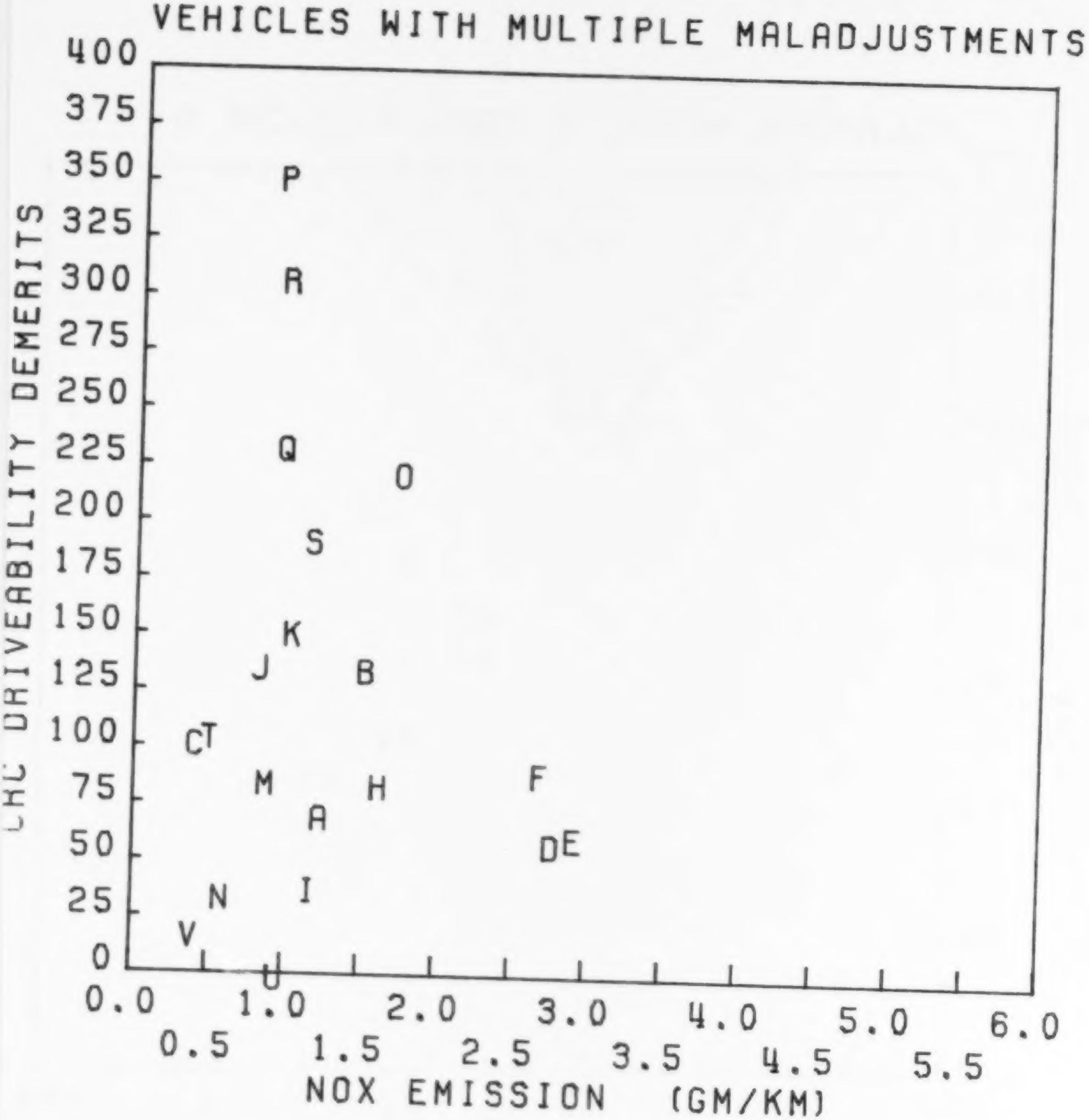

VEHICLES WITH MULTIPLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
ACCELERATION TIME (SECS.)
0
2
4
6
8
10
12
14
16
18
20
P
R
Q
O
S
K
B
J
C
T
F
M
H
A
E
D
I
N
V
U

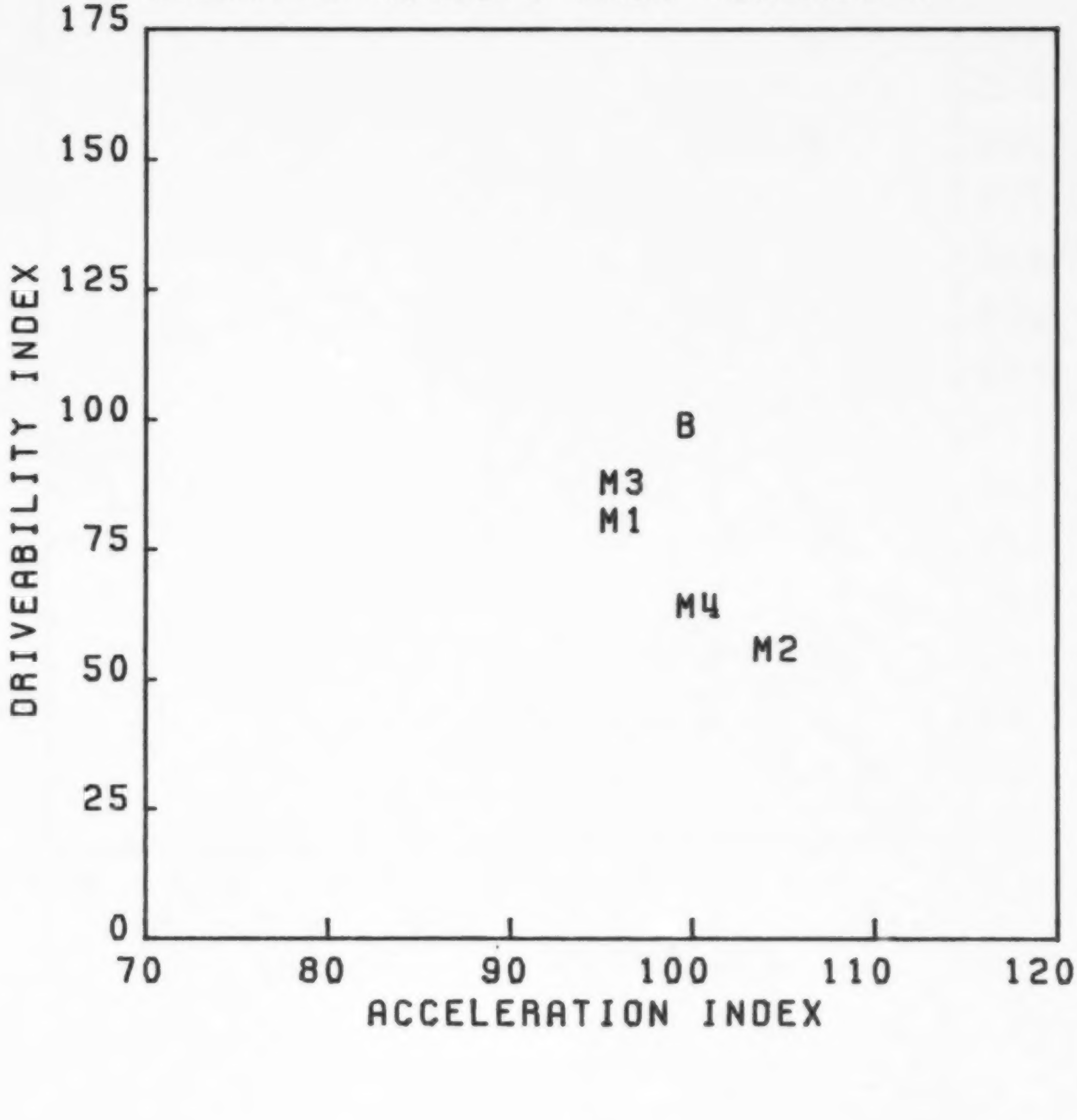

VEHICLES WITH MULTIPLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
FTP FUEL CONSUMPTION (L/1000KM)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
P
R
Q
O
S
K
J
B
T
C
F
H
M
A
E
D
I
N
V
U


VEHICLES WITH MULTIPLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
0
4
8
12
16
20
24
2
6
10
14
18
22
26
HFET FUEL CONSUMPTION (L/1000KM)
P
R
Q
O
S
K
J
B
T
C
F
H
M
A
E
D
I
N
V
U

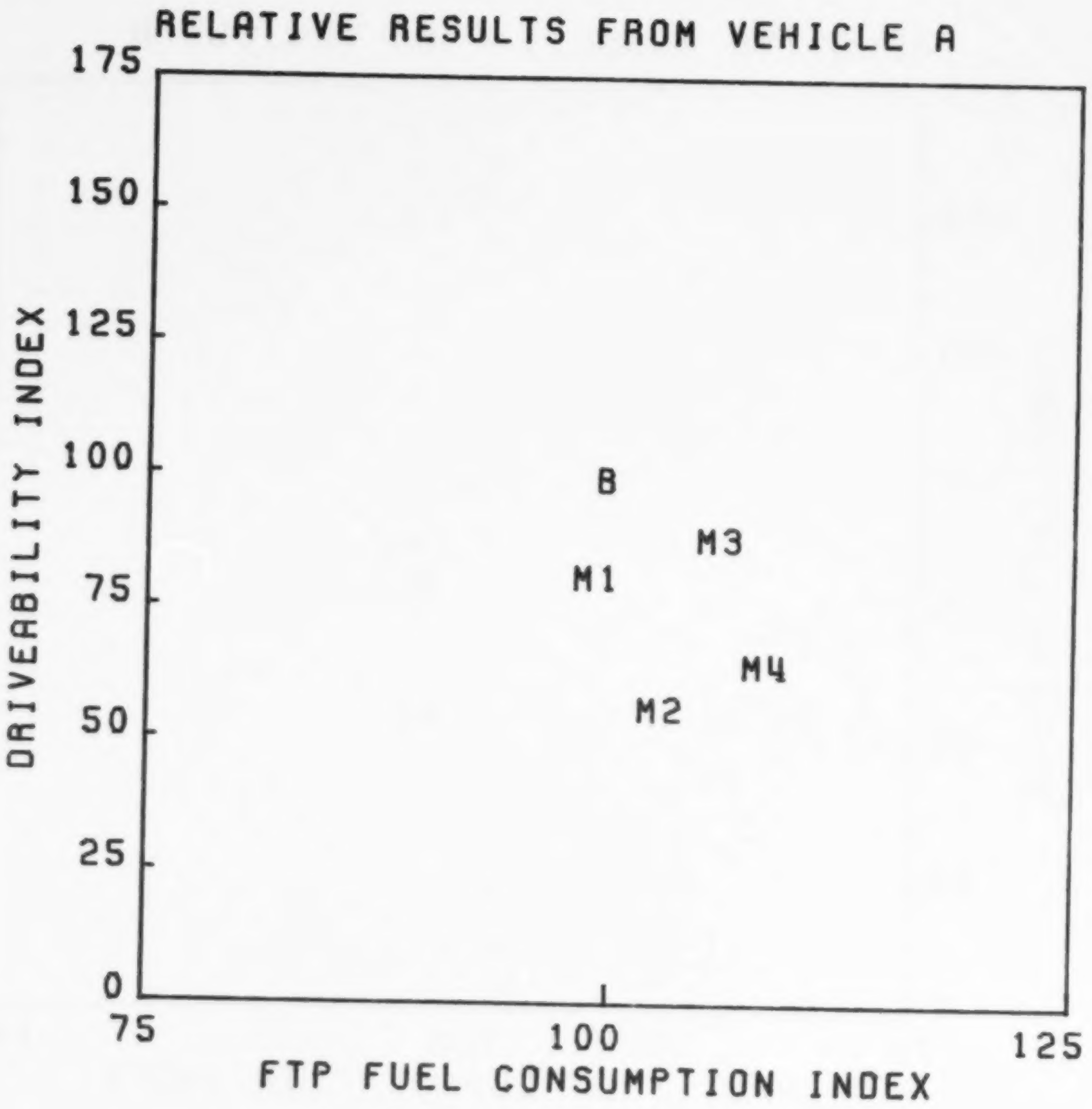

VEHICLES WITH MULTIPLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
HC EMISSION (GM/KM)
0.0
0.4
0.8
1.2
1.6
2.0
P
R
Q
O
S
K
J
B
T
C
H
M
F
A
E
D
I
N
V
U

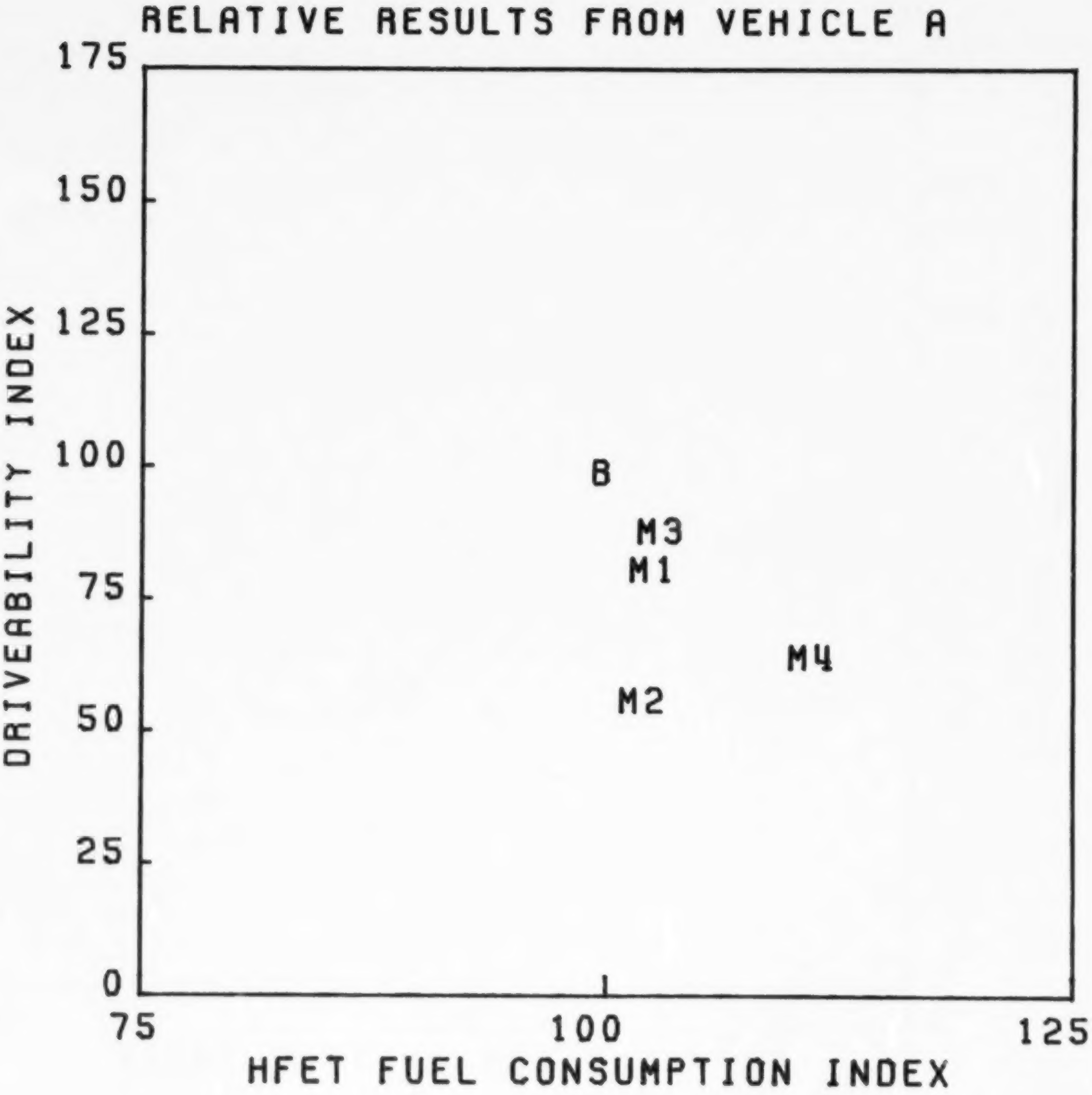

VEHICLES WITH MULTIPLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
P
R
Q
O
S
K
J
B
T
C
M
H
F
A
E
D
N
I
V
U
0
5
10
15
20
25
30
35
40
45
50
55
60
65
CO EMISSION (GM/KM)

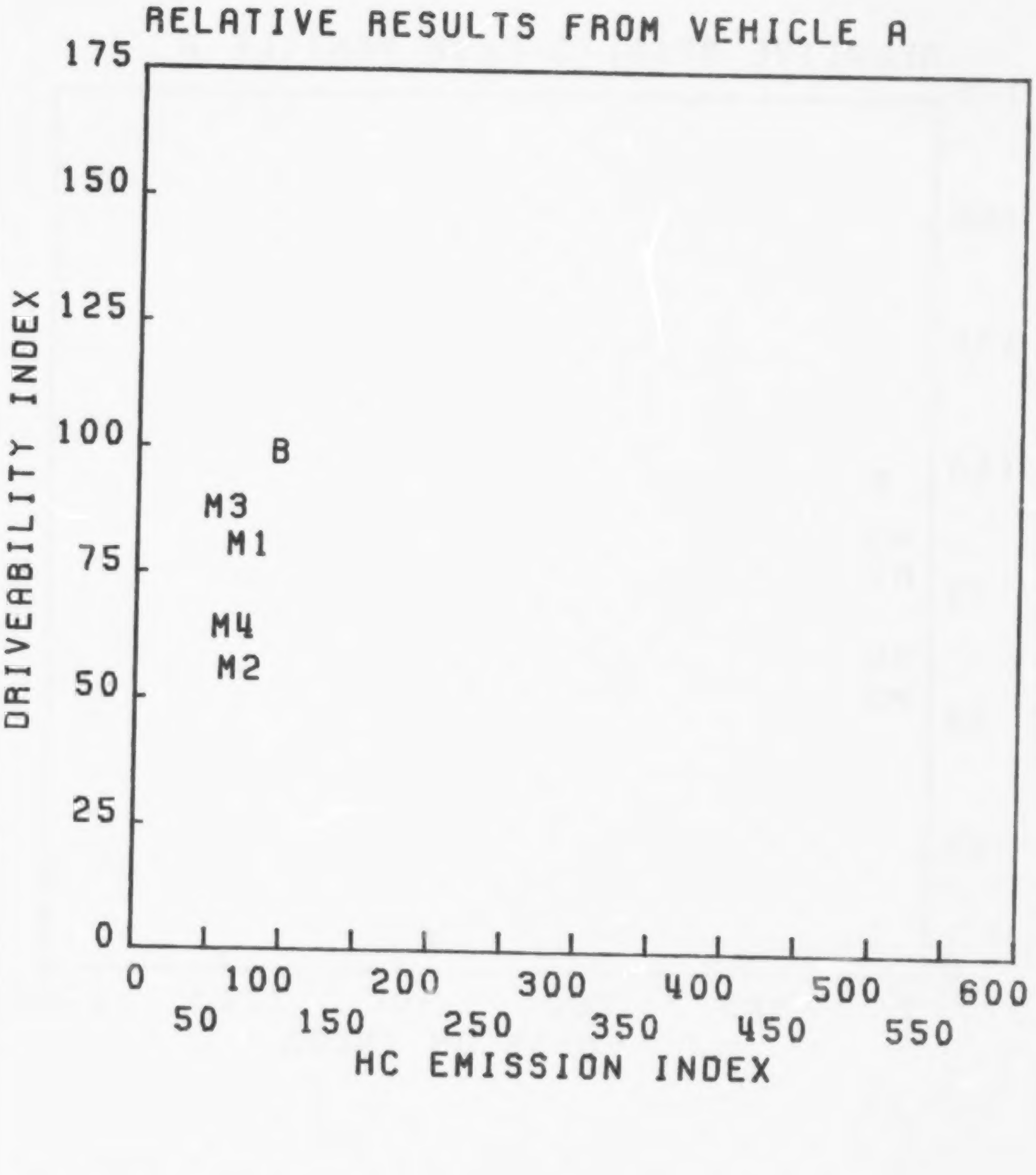

VEHICLES WITH MULTIPLE MALADJUSTMENTS
CRC DRIVEABILITY DEMERITS
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
NOX EMISSION (GM/KM)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
P
R
Q
O
S
K
J
B
C
T
M
H
F
A
D
E
N
I
V
U

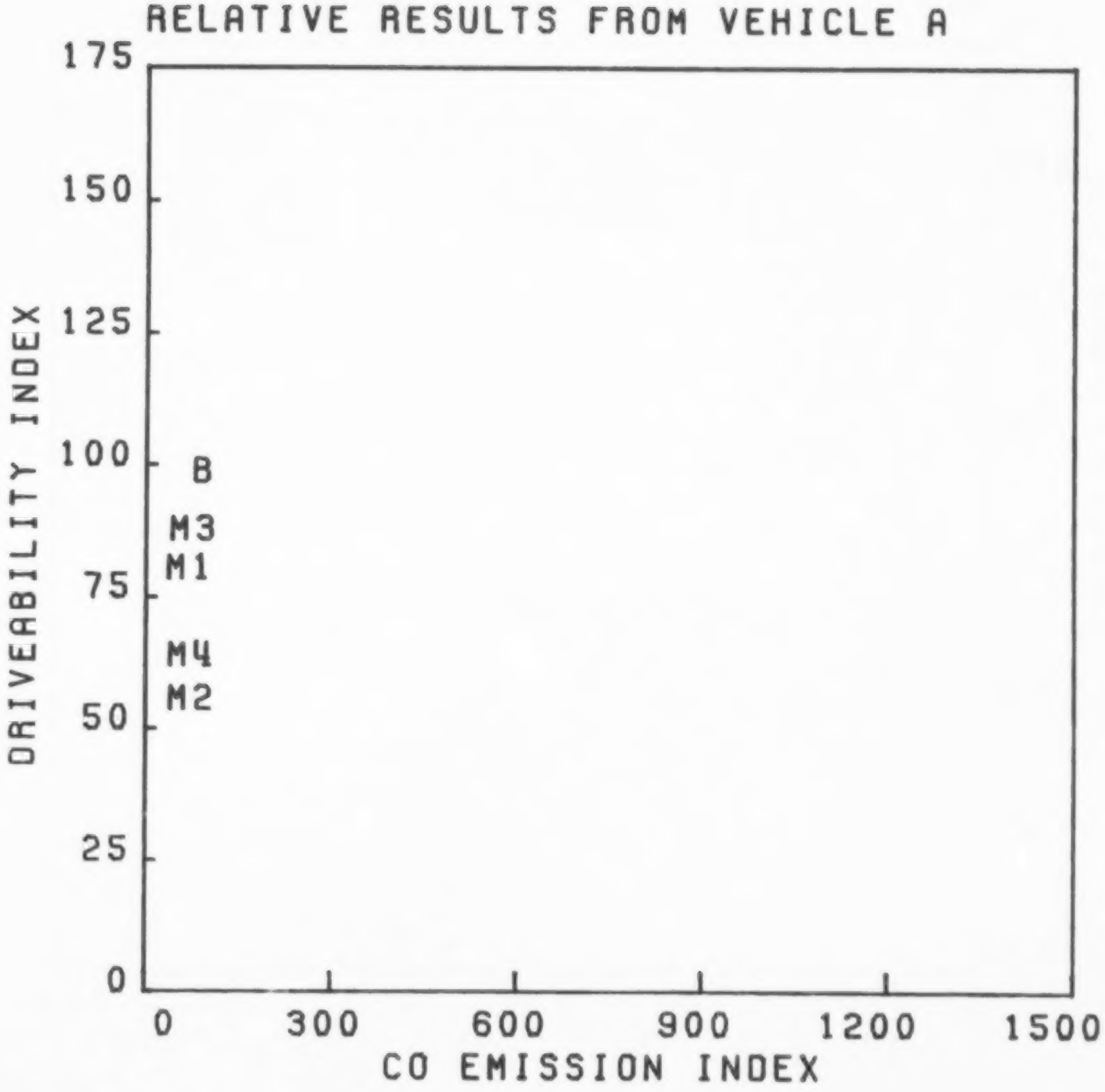


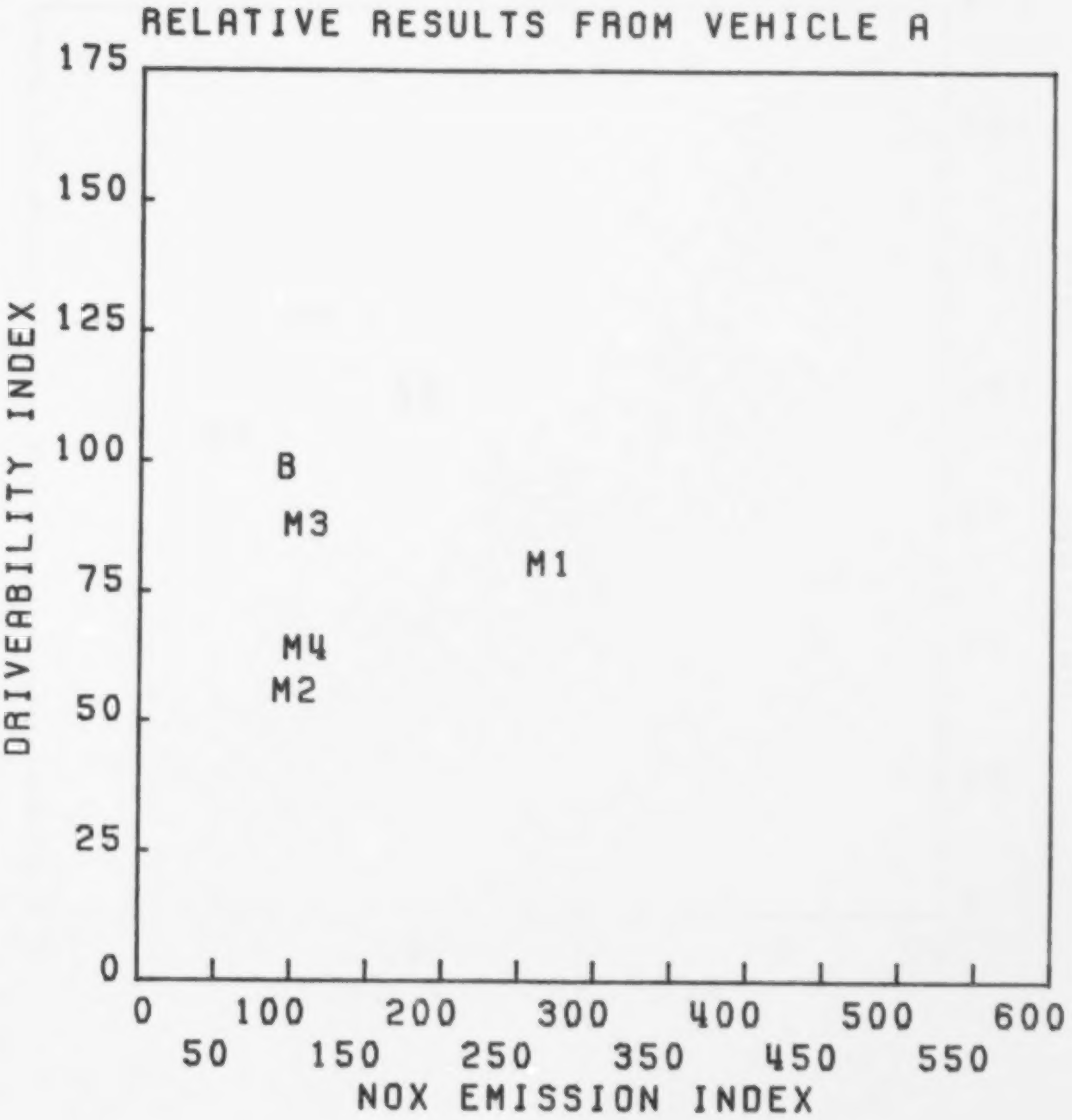
RELATIVE RESULTS FROM VEHICLE A

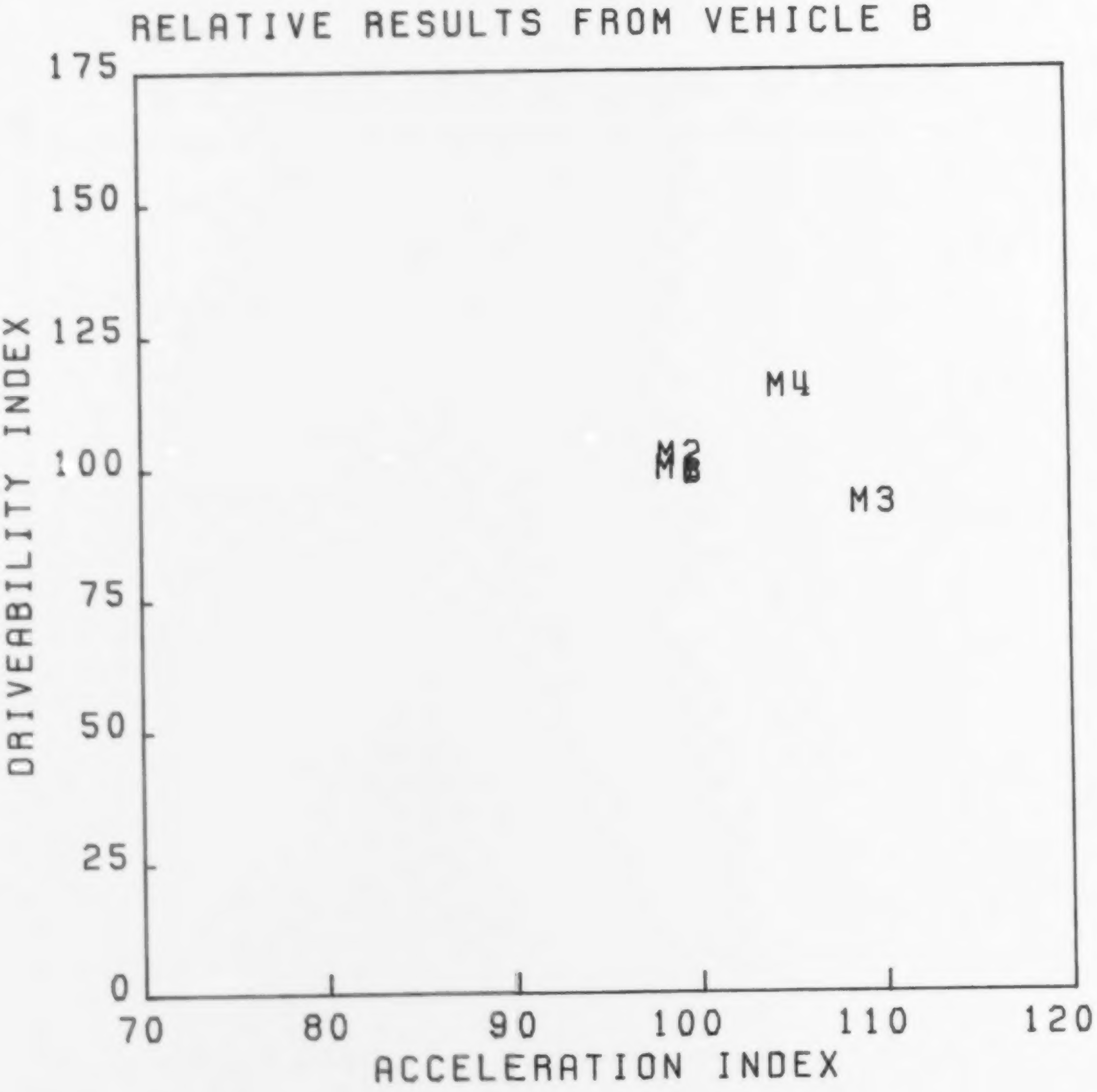

RELATIVE RESULTS FROM VEHICLE A
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
FTP FUEL CONSUMPTION INDEX
B
M3
M1
M4
M2

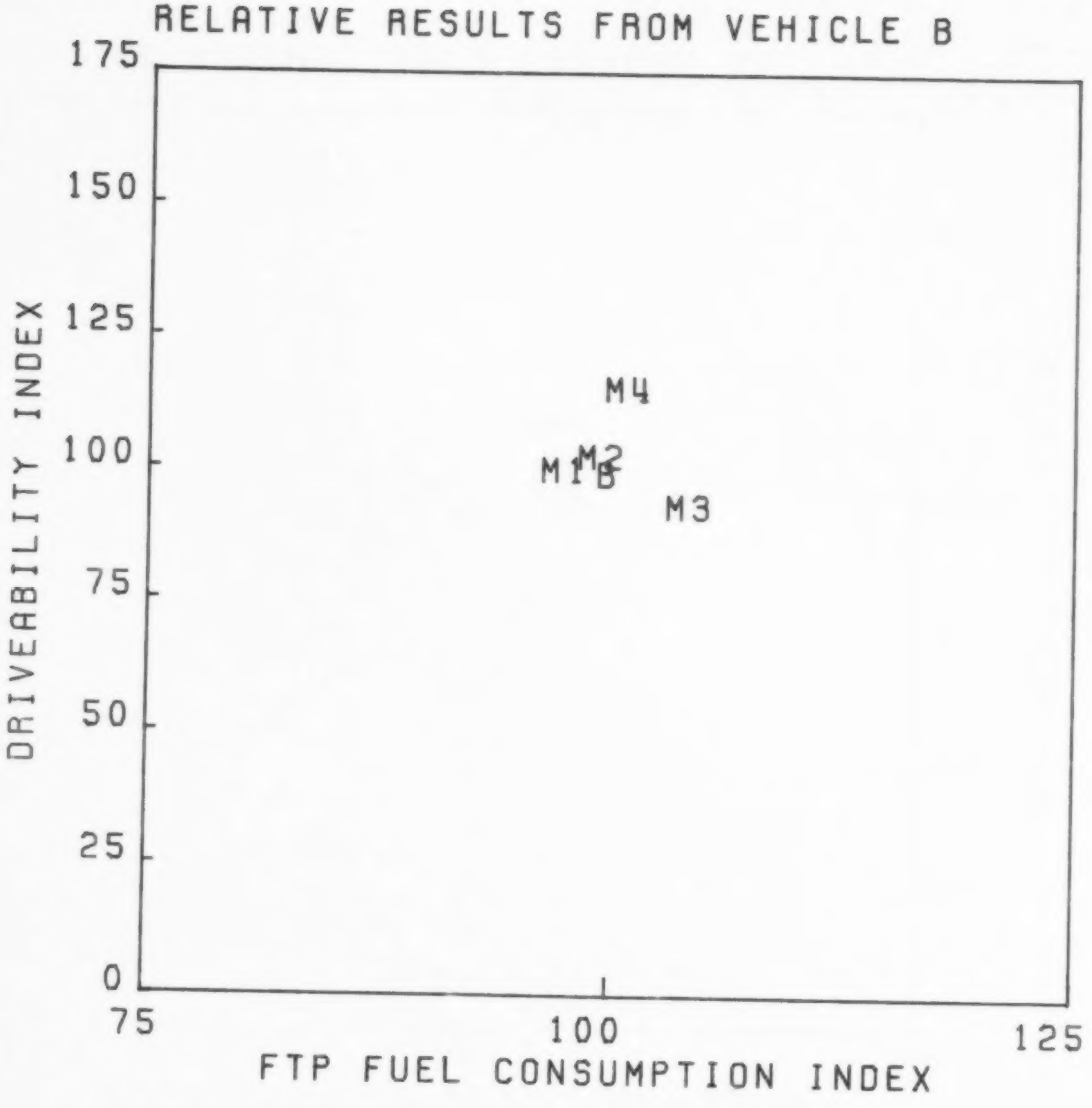

RELATIVE RESULTS FROM VEHICLE A
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
B
M3
M1
M4
M2
75
100
125
HFET FUEL CONSUMPTION INDEX

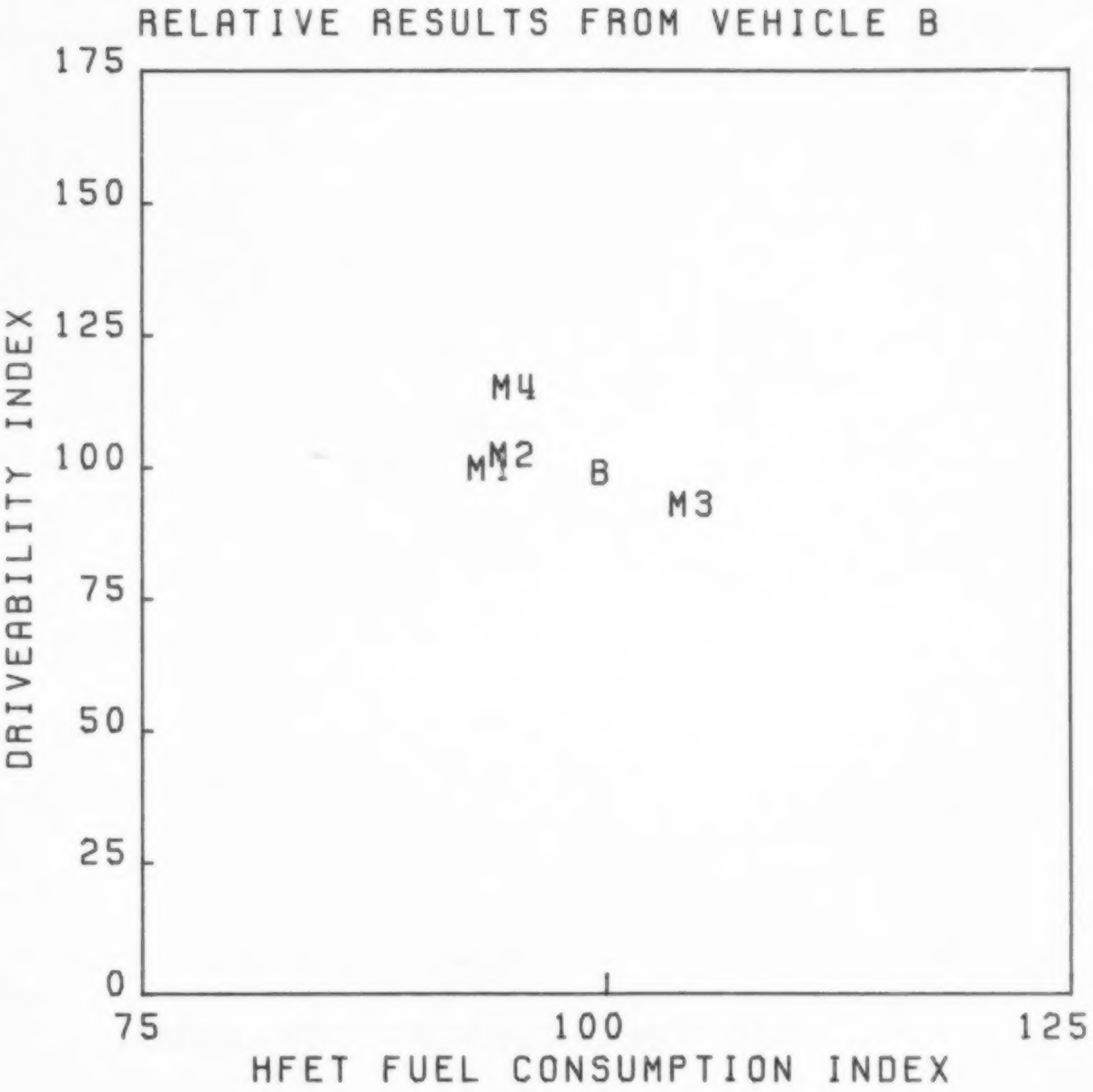

RELATIVE RESULTS FROM VEHICLE A
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
HC EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
B
M3
M1
M4
M2

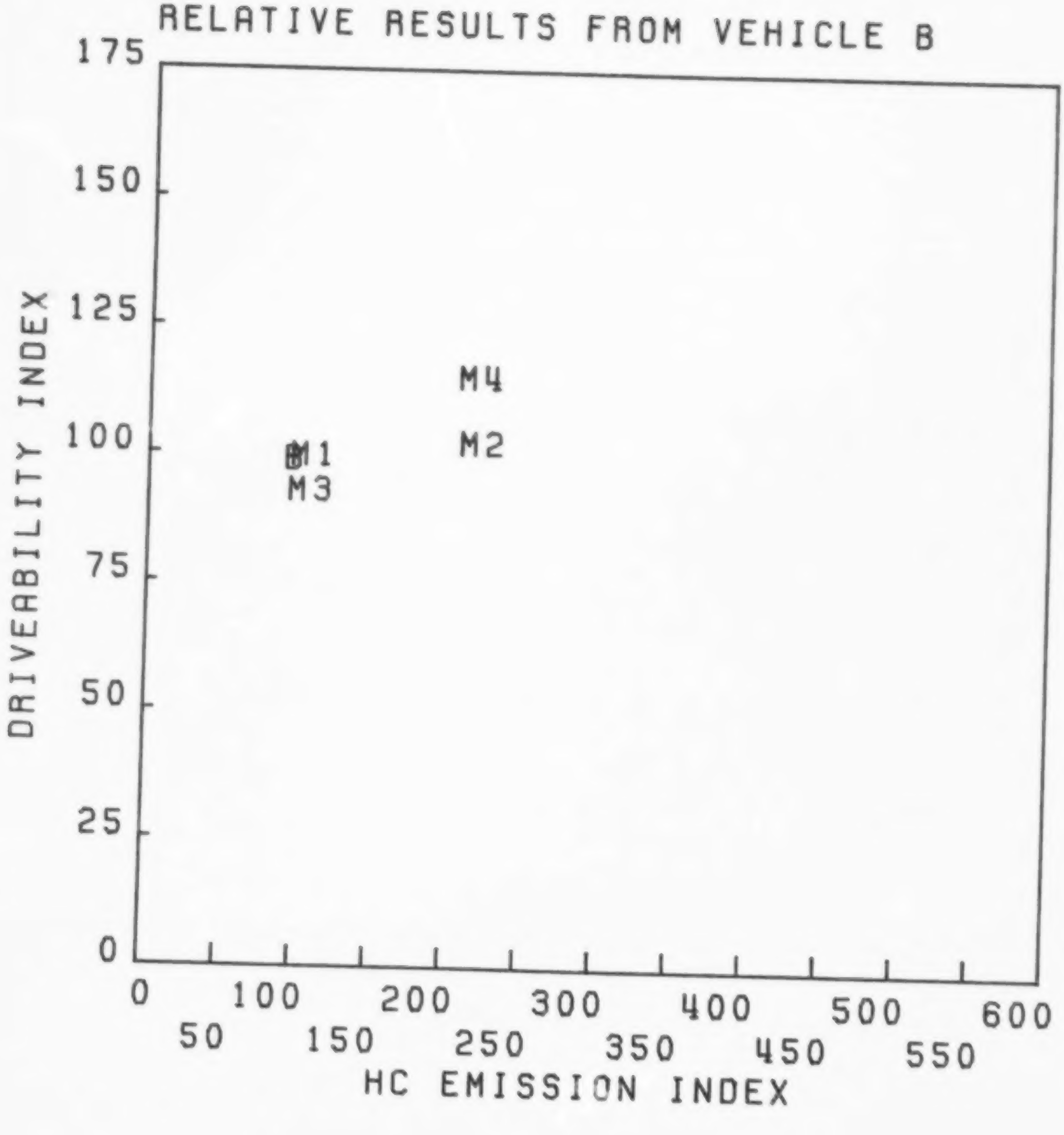

RELATIVE RESULTS FROM VEHICLE A
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M3
M1
M4
M2
0
300
600
900
1200
1500
CO EMISSION INDEX

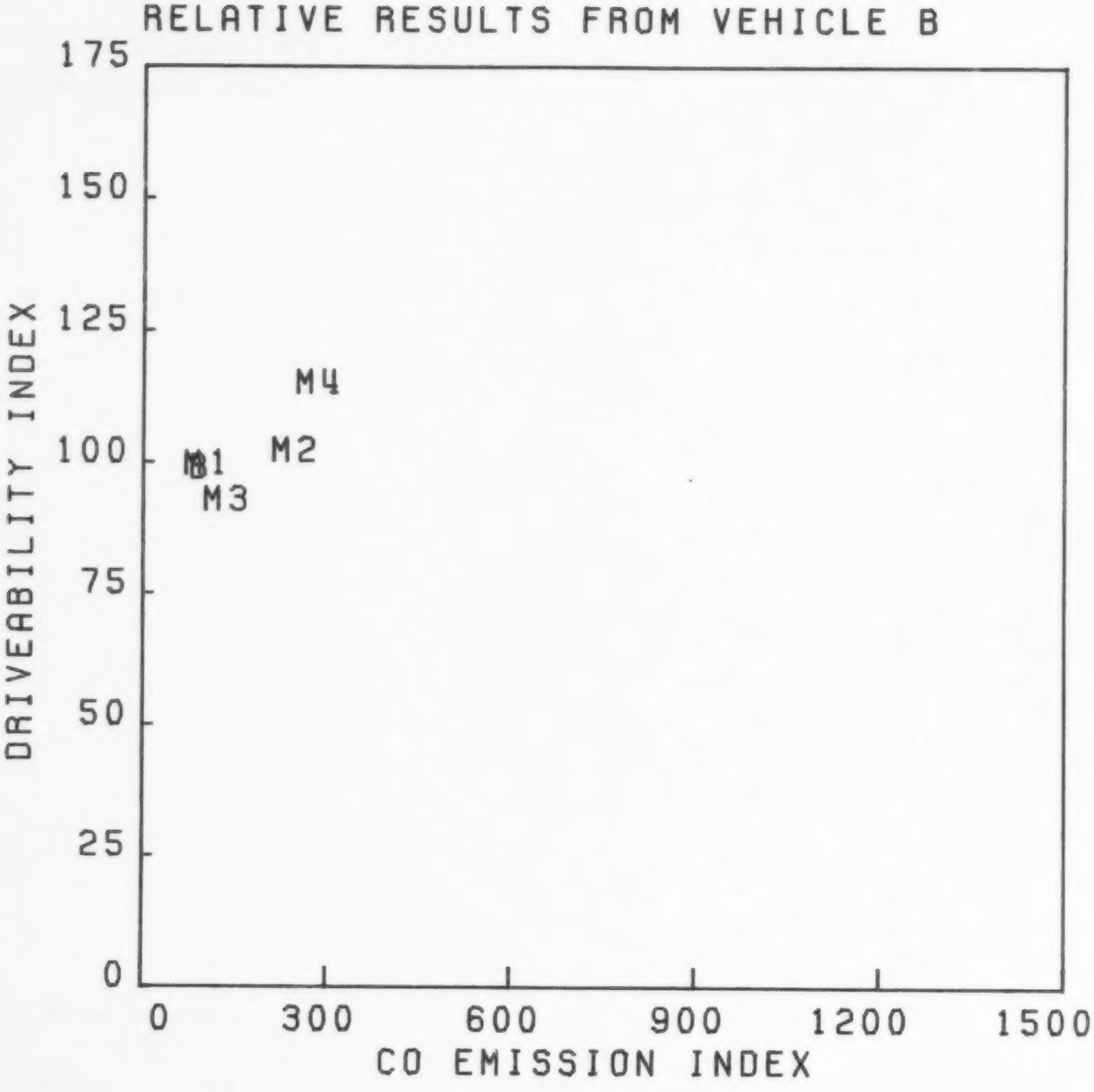

RELATIVE RESULTS FROM VEHICLE A
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M3
M1
M4
M2
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX

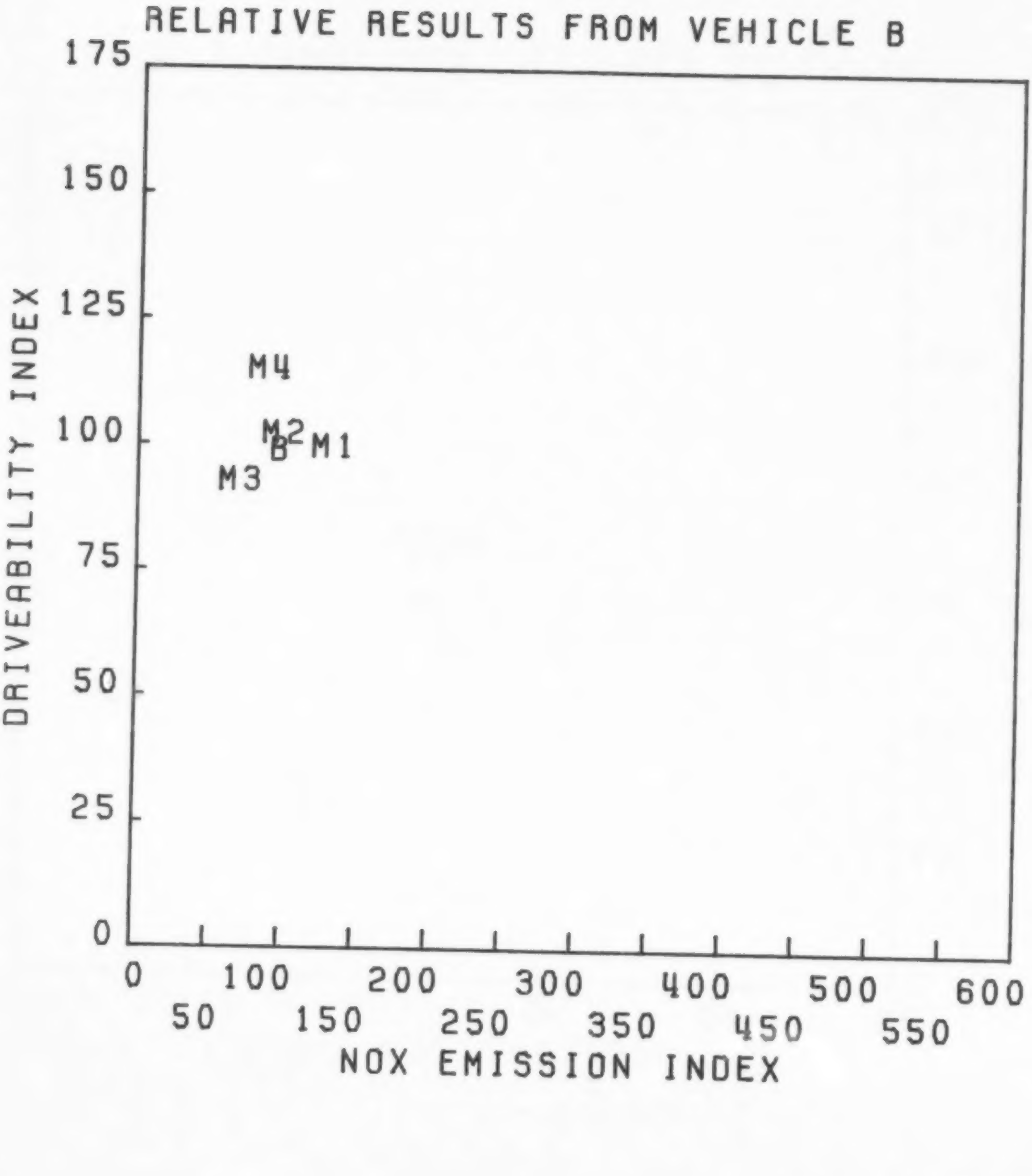

RELATIVE RESULTS FROM VEHICLE B
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
ACCELERATION INDEX
M4
M2
MB
M3

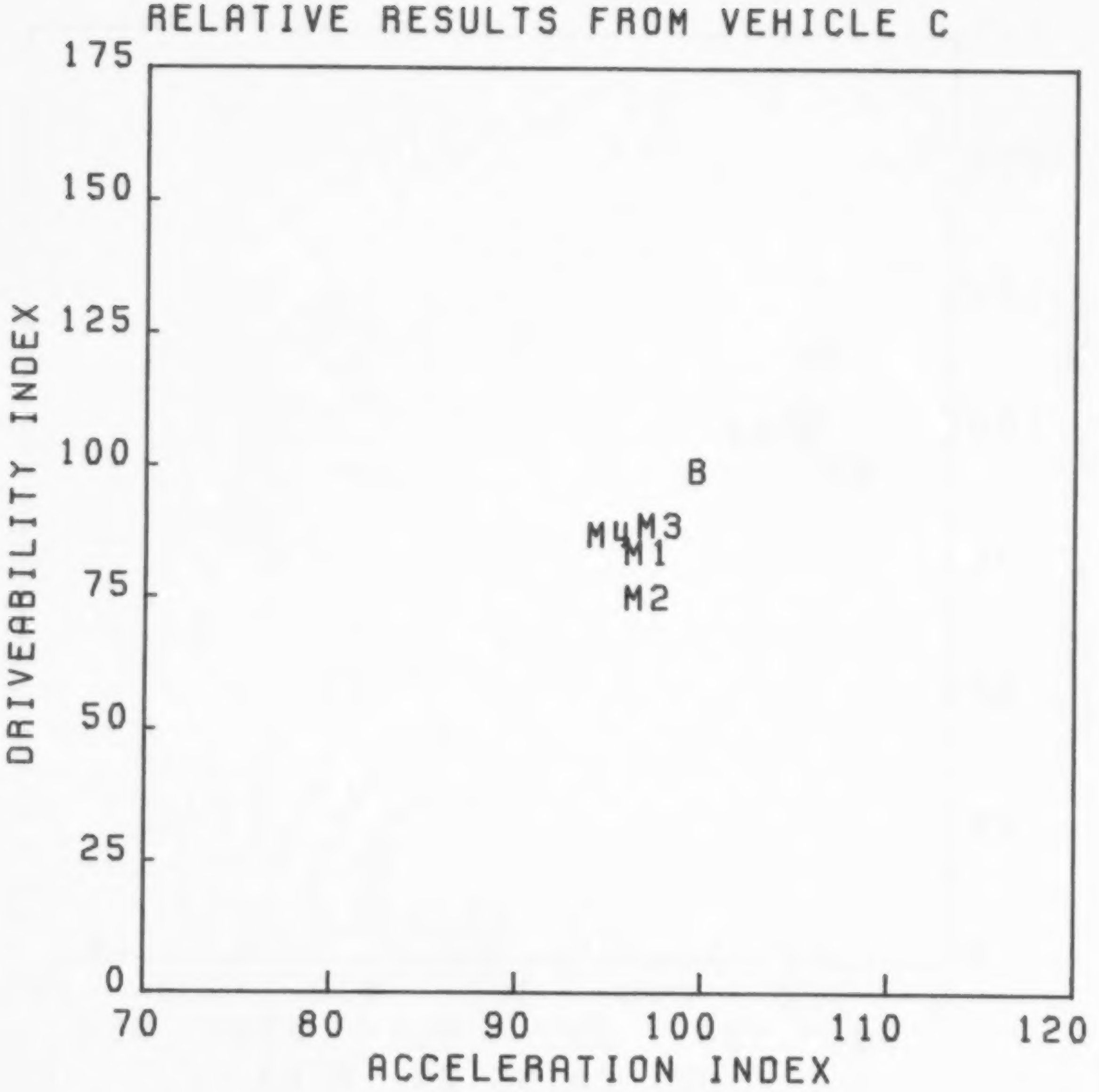

RELATIVE RESULTS FROM VEHICLE B
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M4
M2
M1
B
M3
75
100
125
FTP FUEL CONSUMPTION INDEX

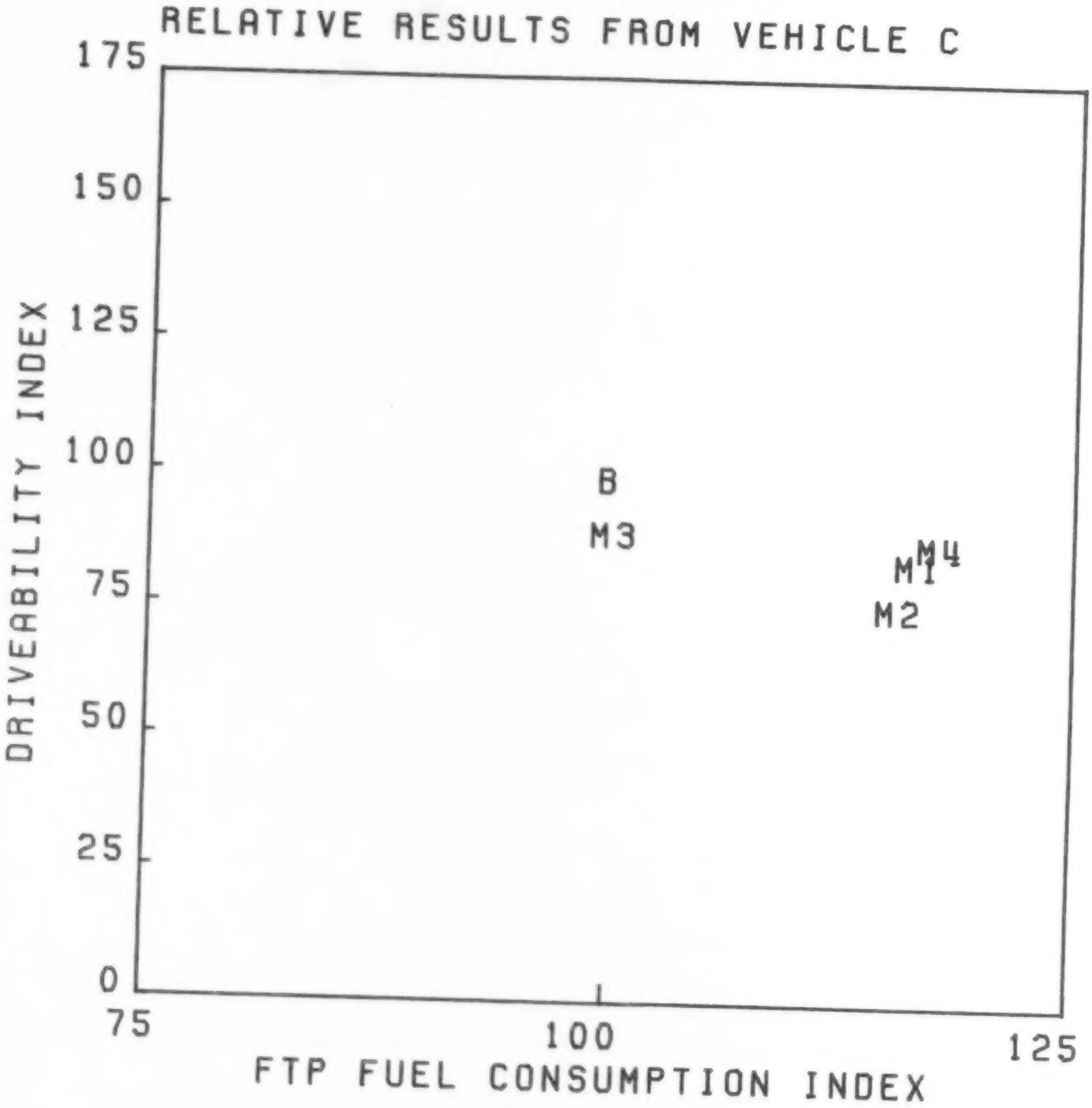
RELATIVE RESULTS FROM VEHICLE B
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M4
M2
M1
B
M3
75
100
125
HFET FUEL CONSUMPTION INDEX

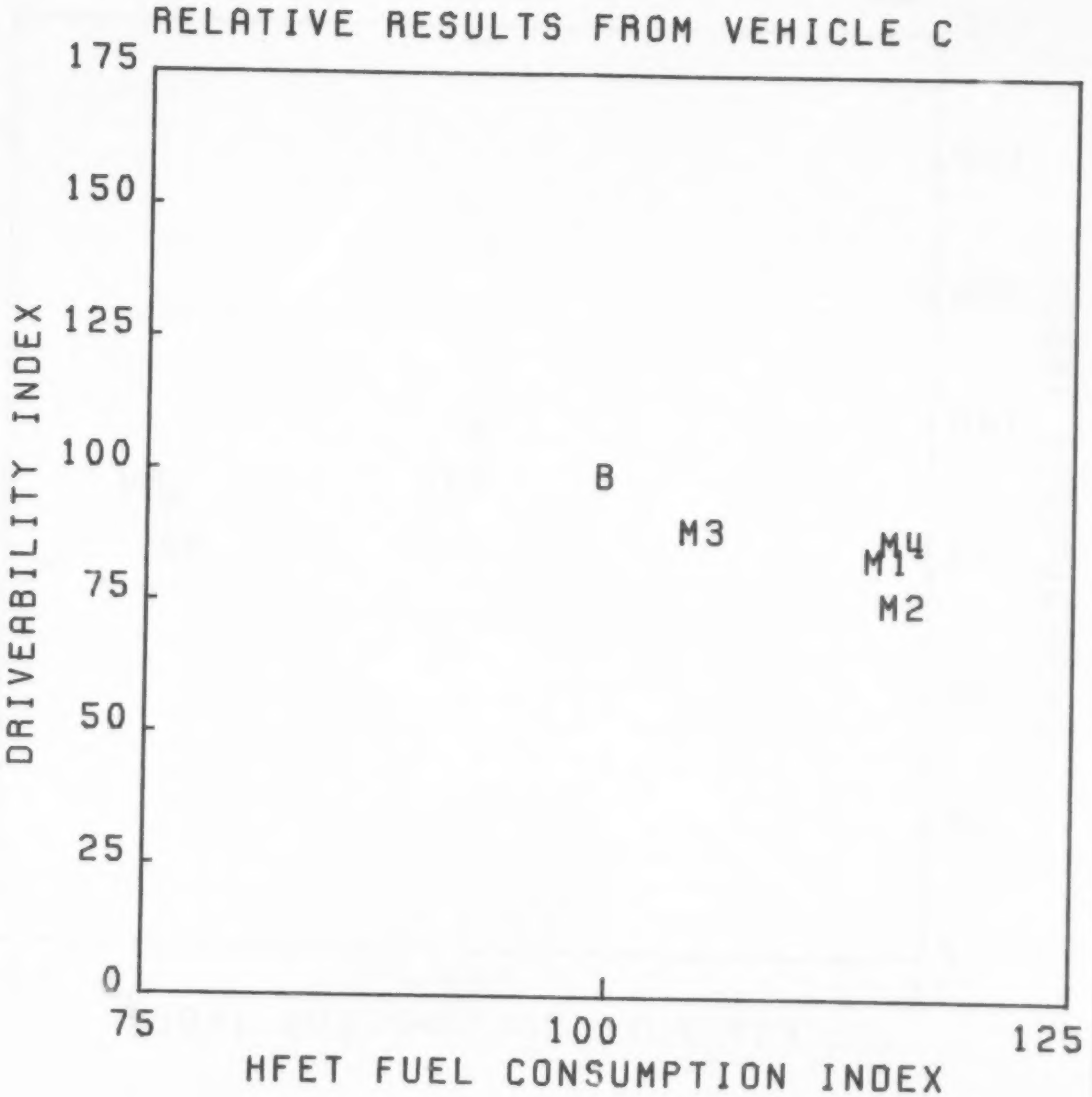

RELATIVE RESULTS FROM VEHICLE B
DRIVEABILITY INDEX
HC EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
B
M1
M3
M4
M2

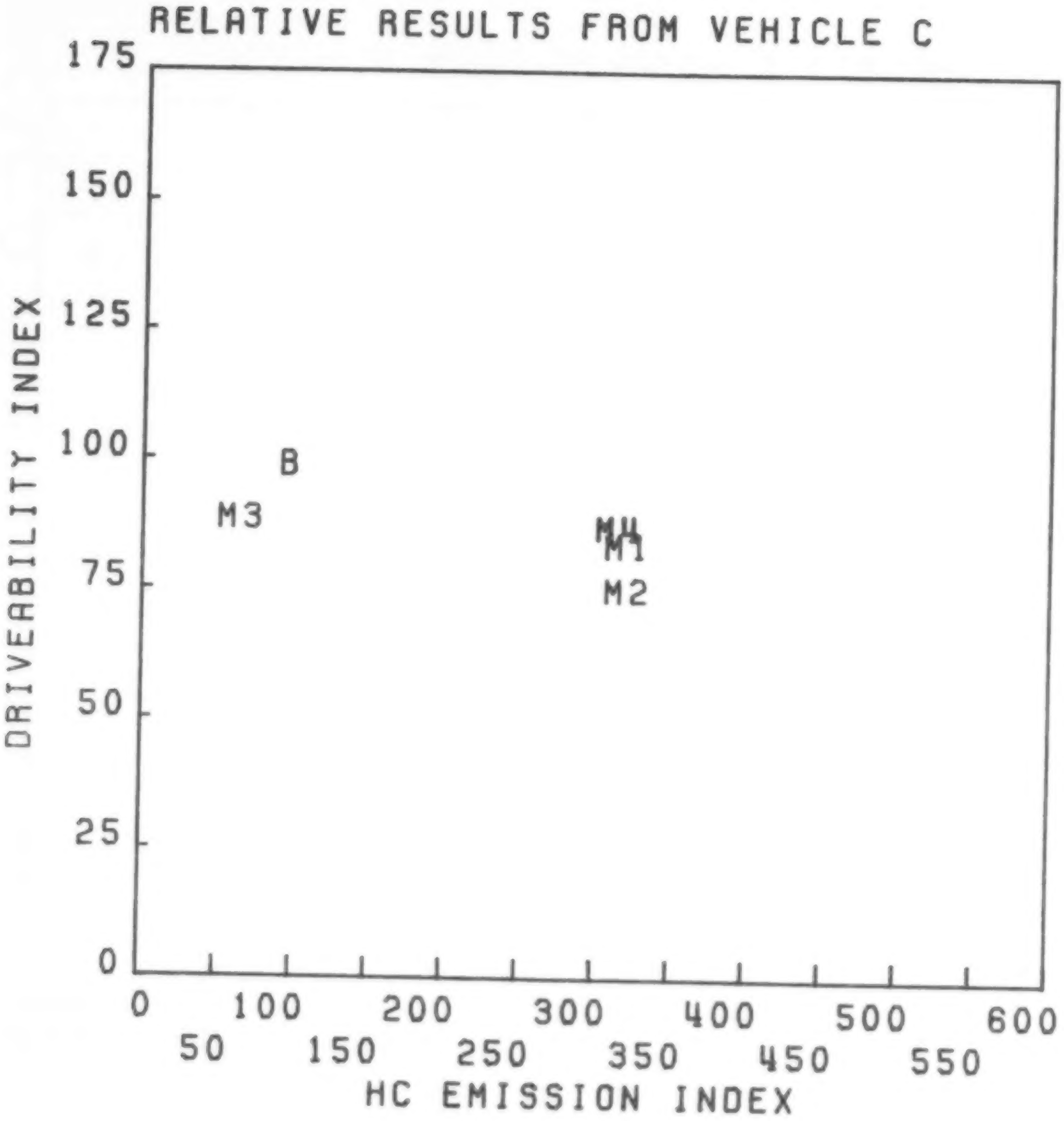

RELATIVE RESULTS FROM VEHICLE B
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
0
300
600
900
1200
1500
CO EMISSION INDEX
M4
M2
B
M1
M3

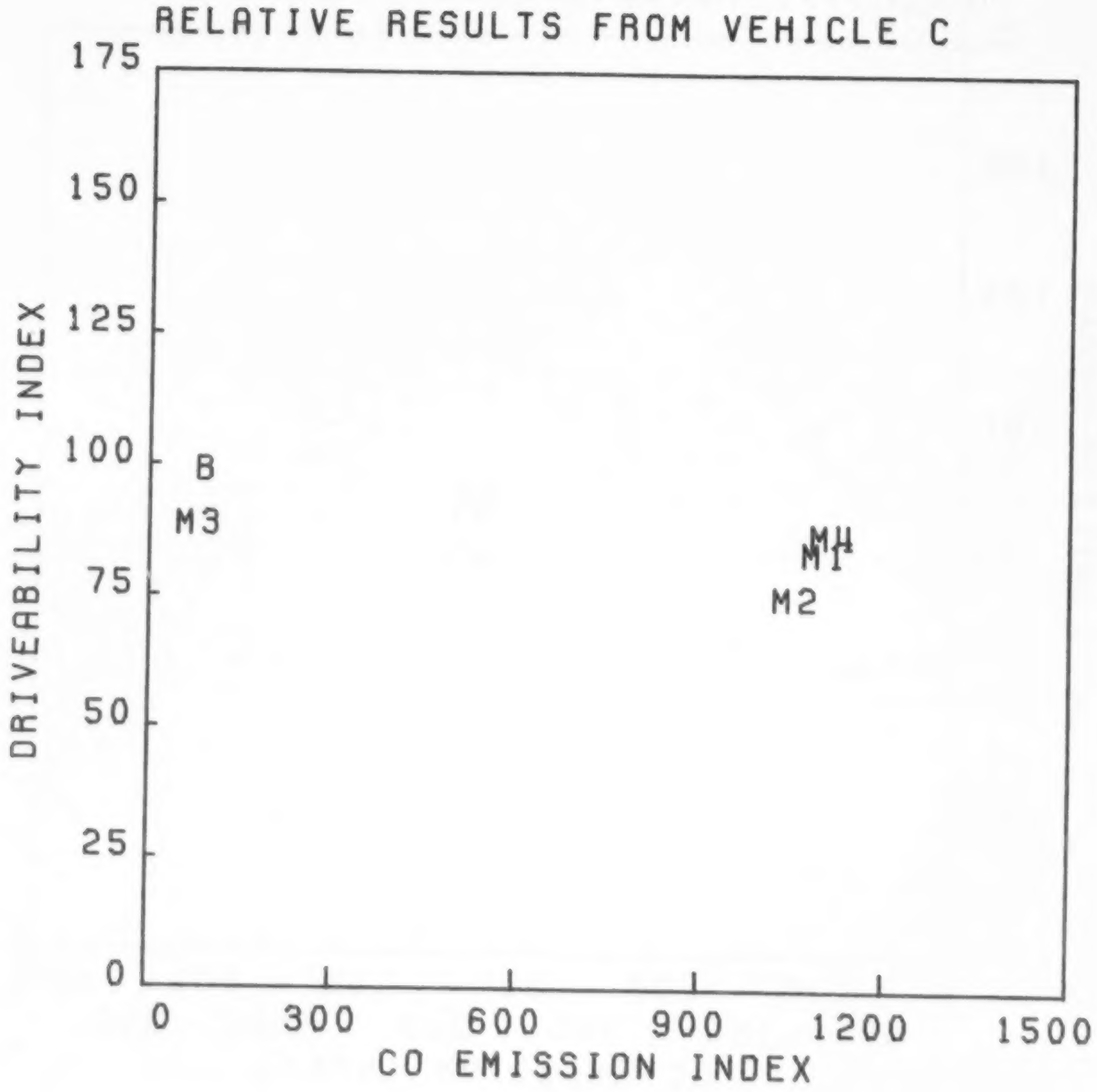

RELATIVE RESULTS FROM VEHICLE B
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
NOX EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
M4
M2
B
M1
M3

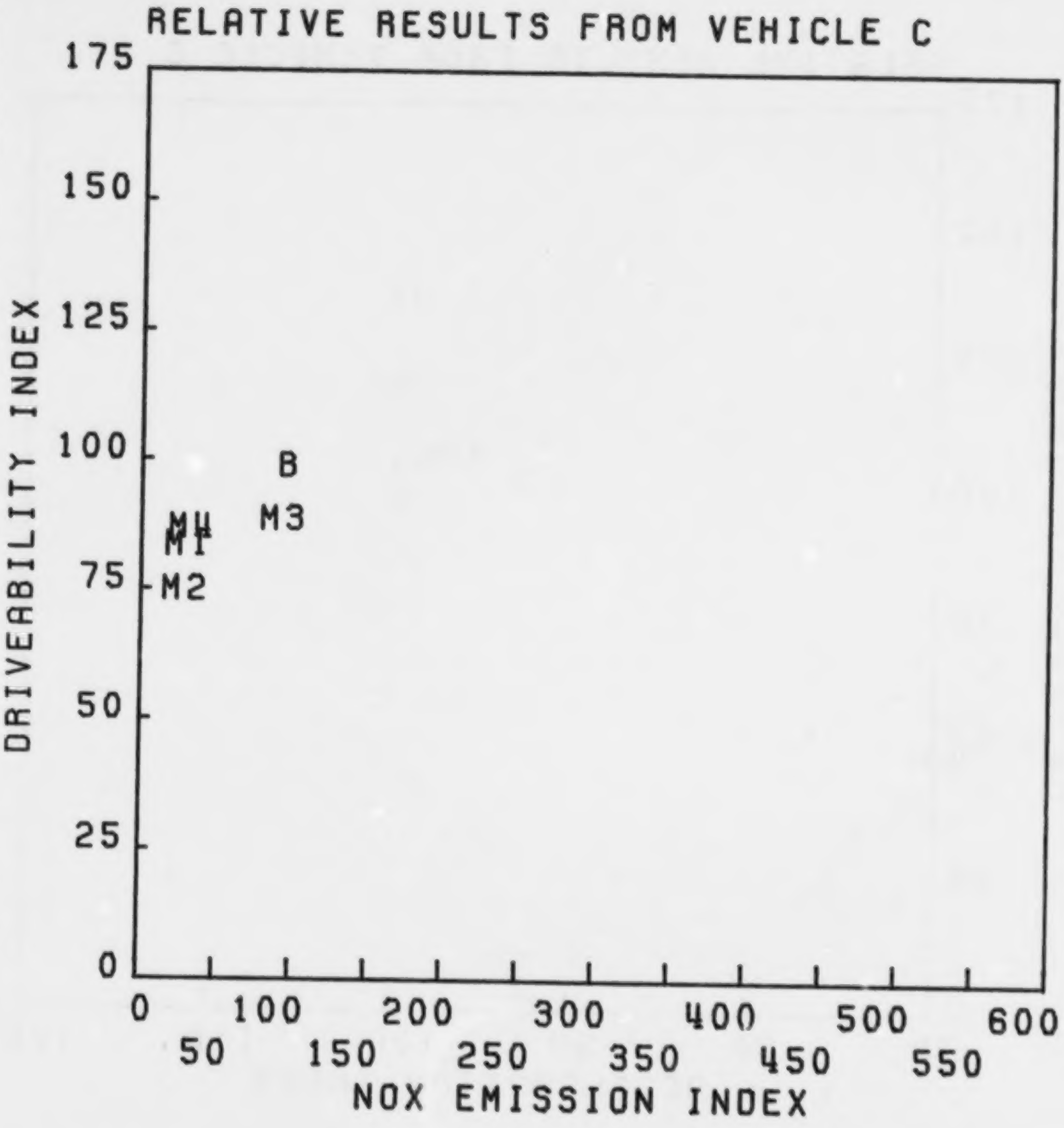

RELATIVE RESULTS FROM VEHICLE C
DRIVEABILITY INDEX
ACCELERATION INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
B
M4
M3
M1
M2


RELATIVE RESULTS FROM VEHICLE C
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
B
M3
M4
M1
M2
75
100
125
FTP FUEL CONSUMPTION INDEX

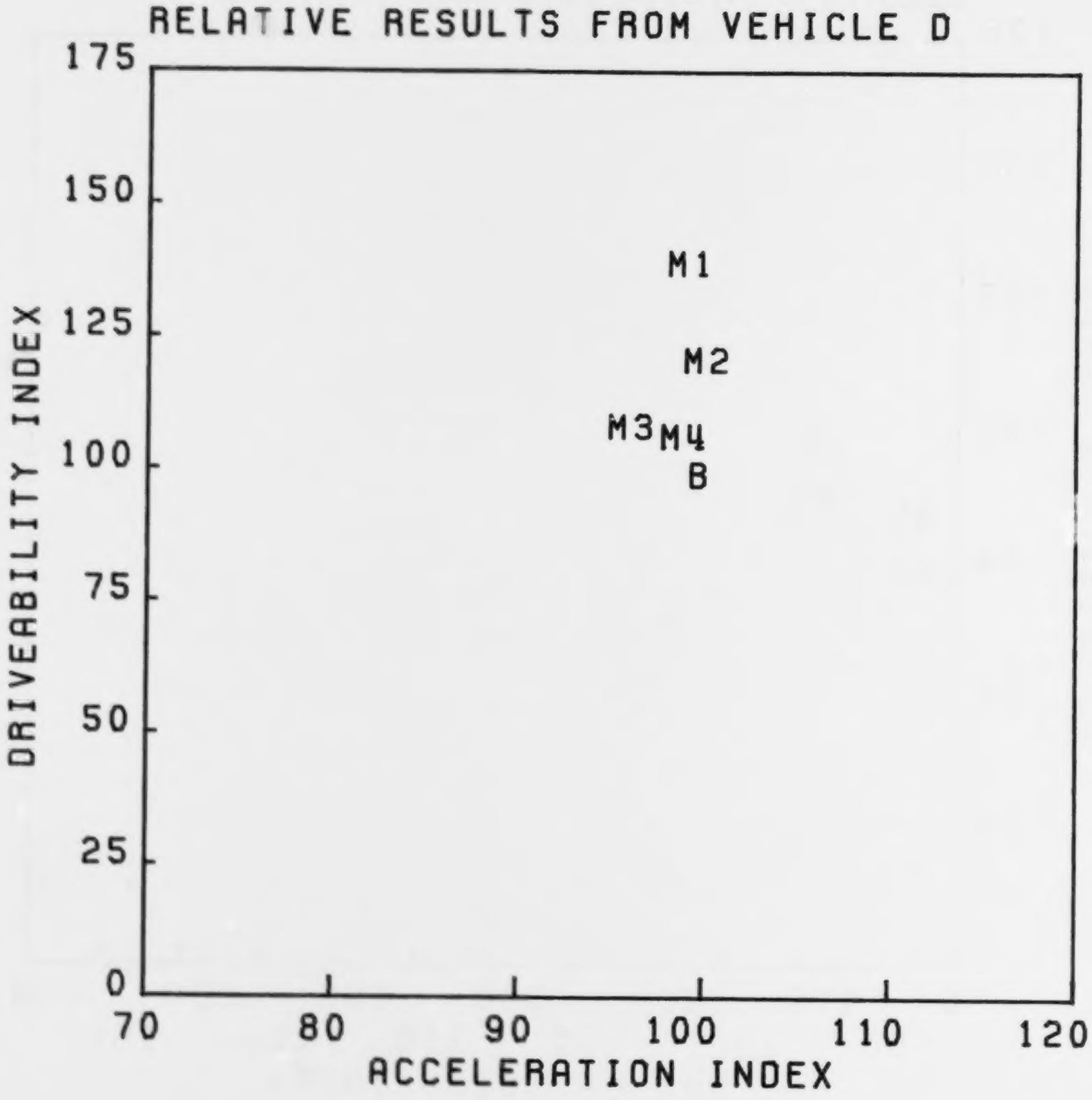

RELATIVE RESULTS FROM VEHICLE C
DRIVEABILITY INDEX
HFET FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
B
M3
M4
M1
M2

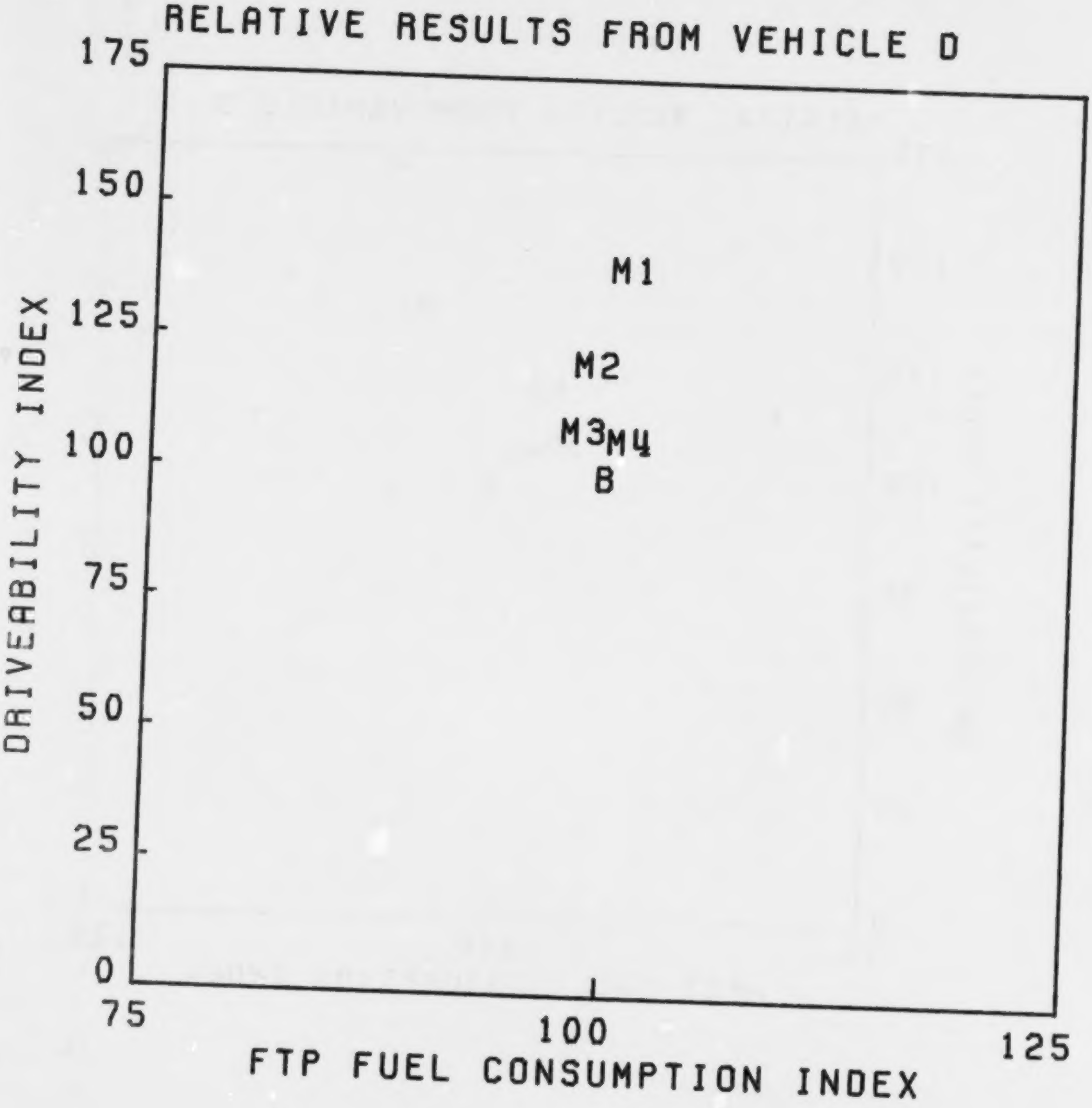

RELATIVE RESULTS FROM VEHICLE C
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M3
M4
M1
M2
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX

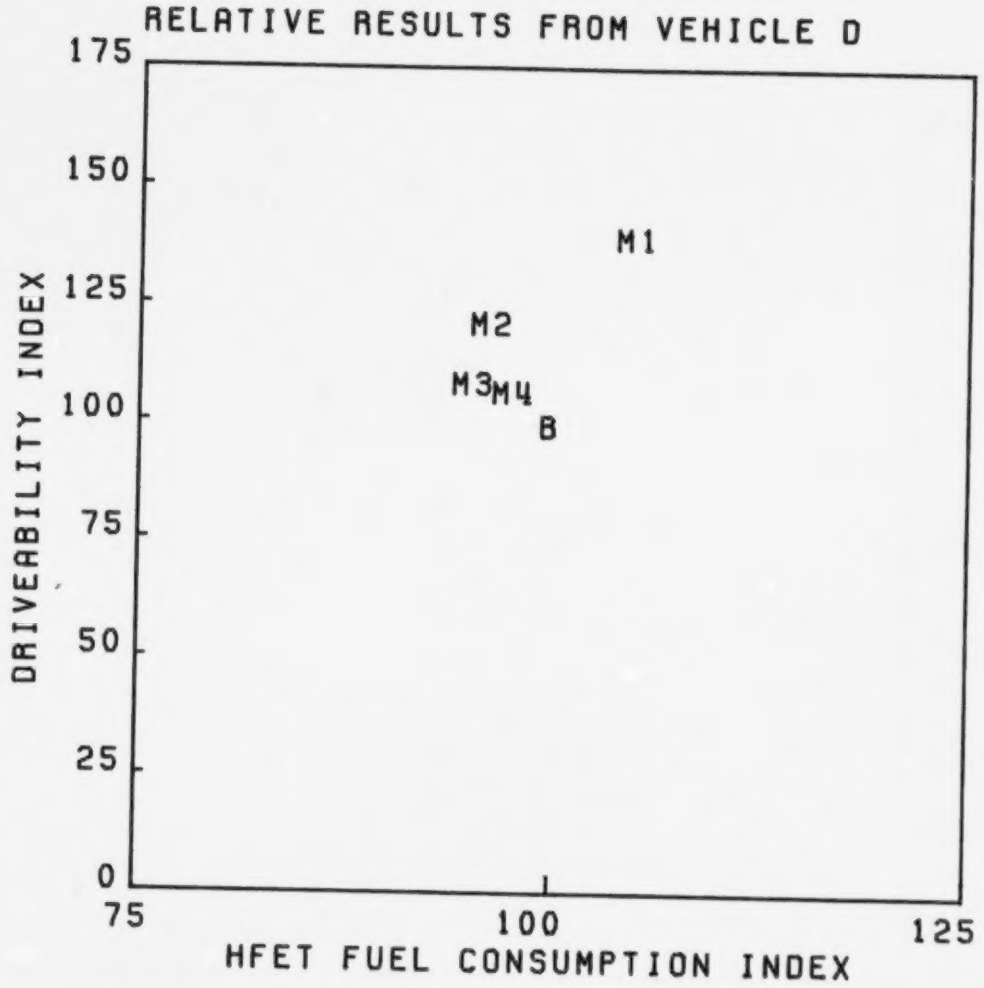

RELATIVE RESULTS FROM VEHICLE C
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
CO EMISSION INDEX
0
300
600
900
1200
1500
B
M3
M4
M1
M2

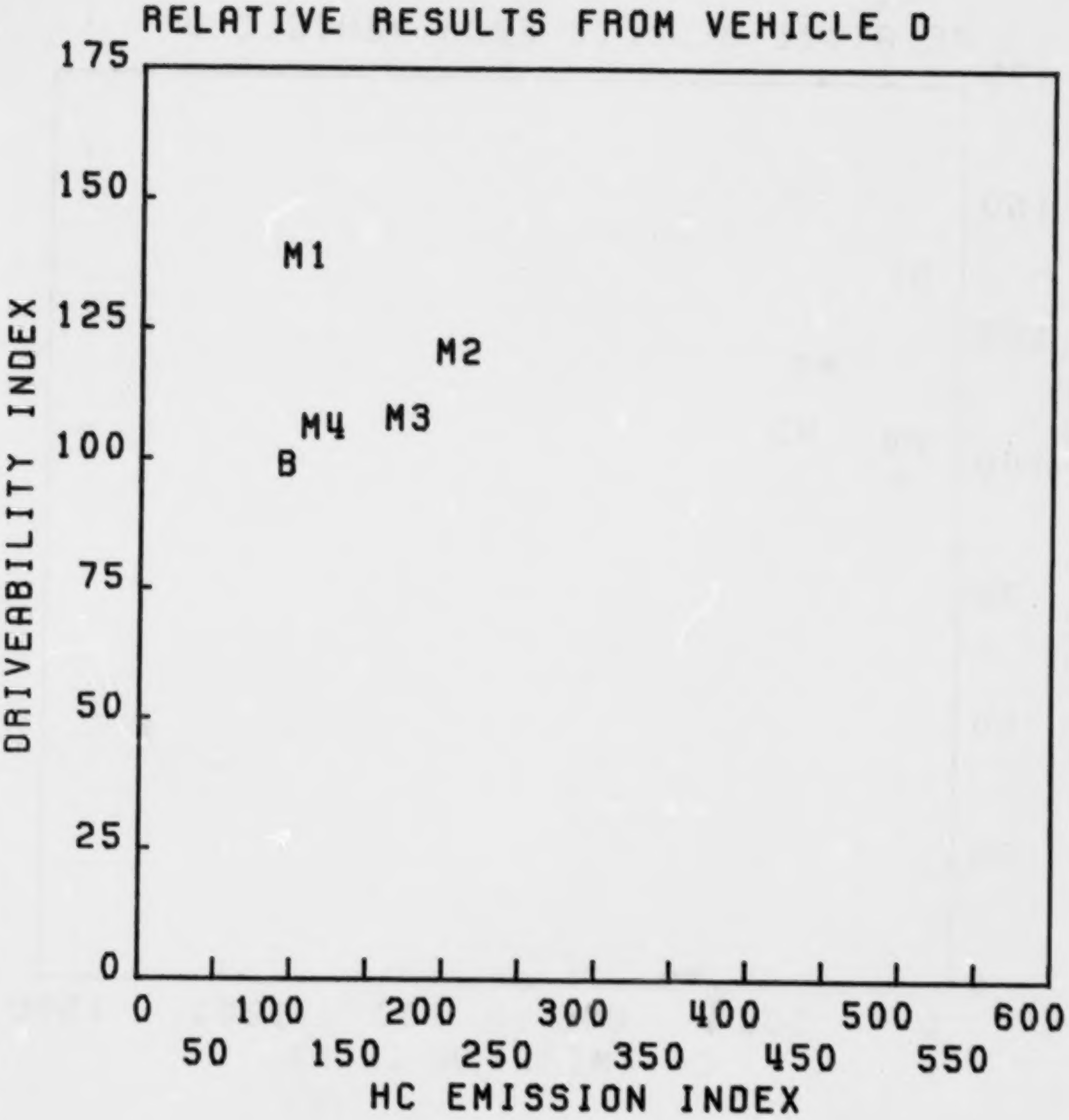


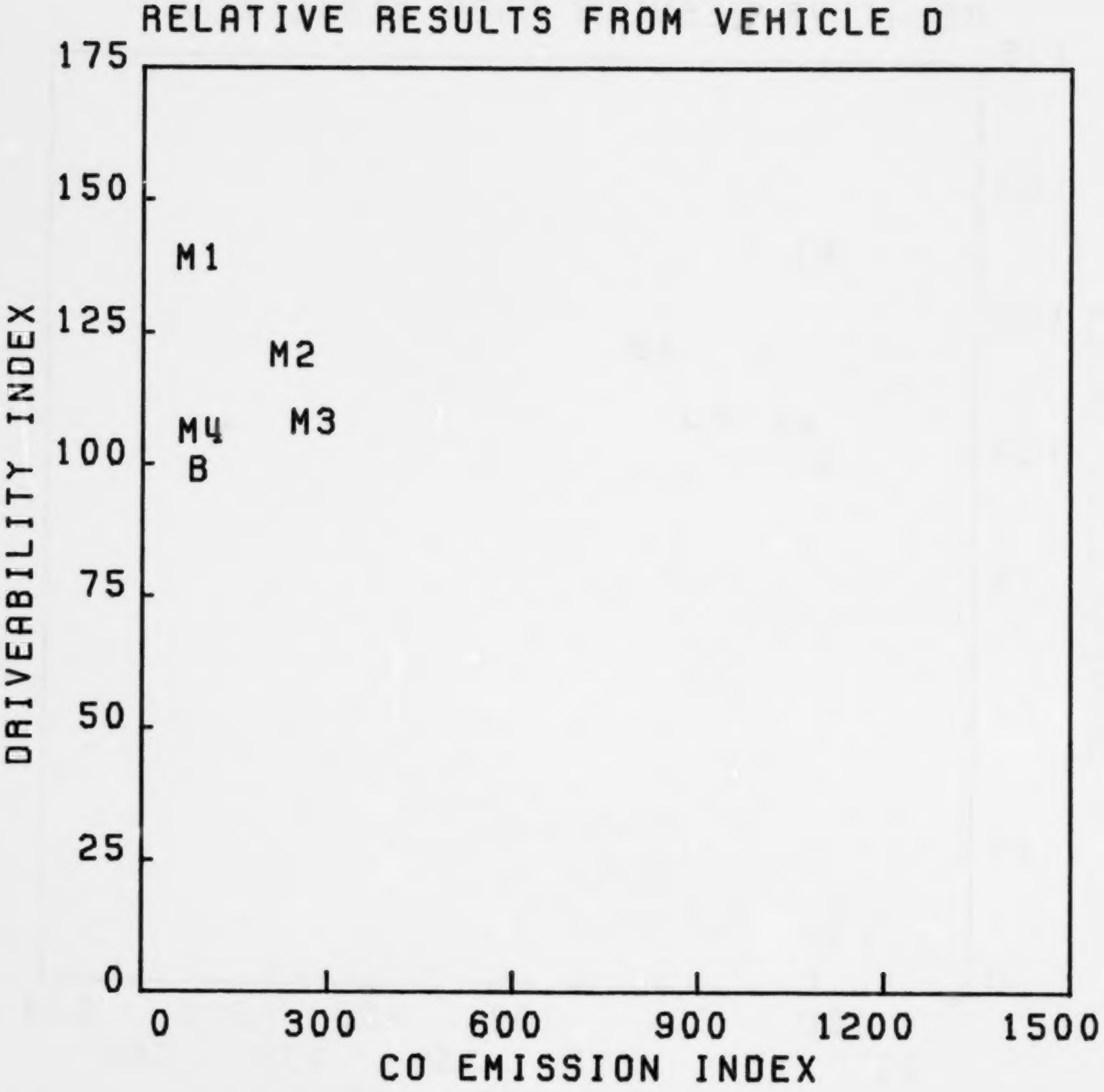
RELATIVE RESULTS FROM VEHICLE C
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
NOX EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
B
M3
M4
M1
M2

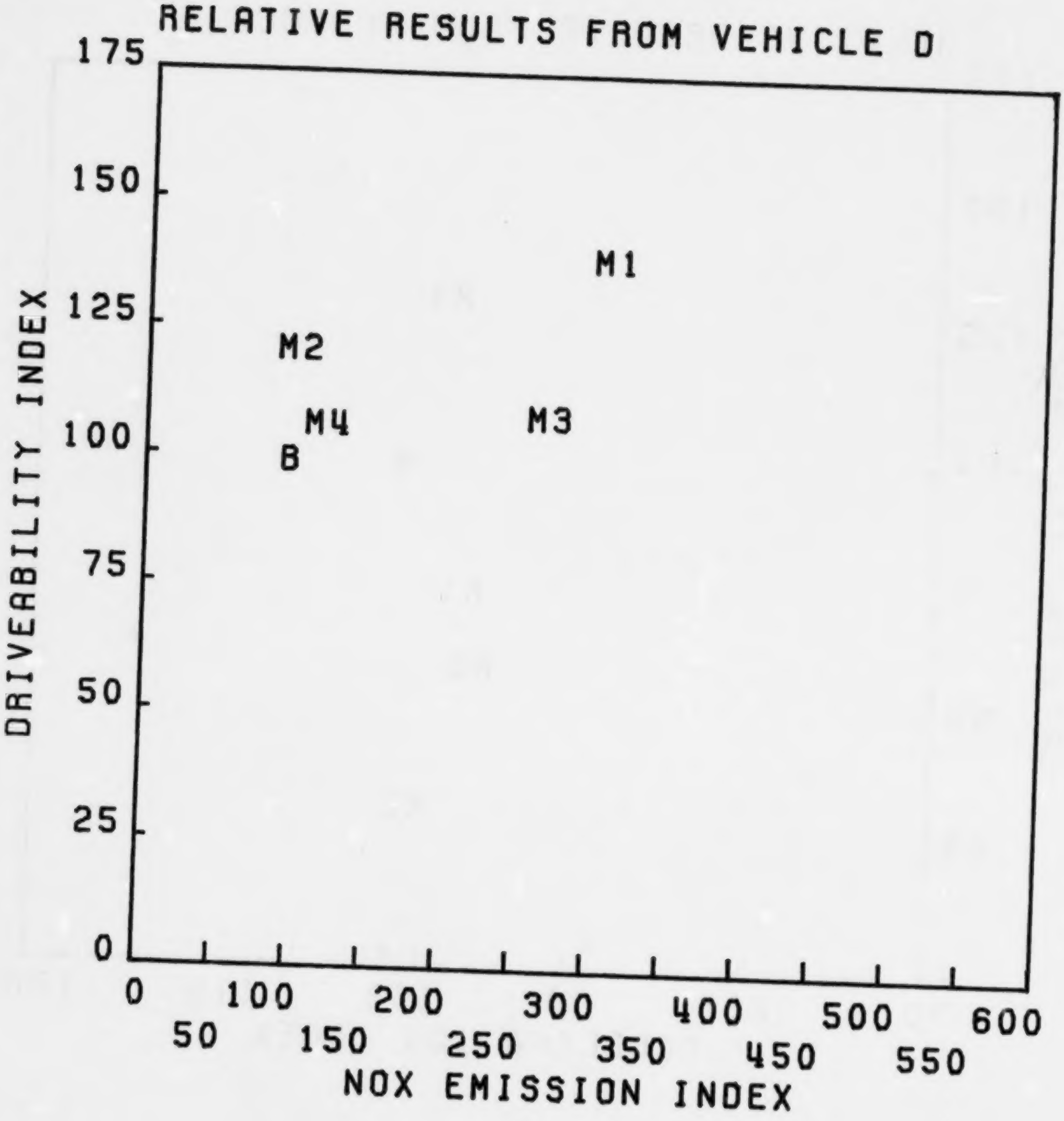

RELATIVE RESULTS FROM VEHICLE D
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
ACCELERATION INDEX
M1
M2
M3
M4
B


RELATIVE RESULTS FROM VEHICLE D
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M1
M2
M3
M4
B
75
100
125
FTP FUEL CONSUMPTION INDEX

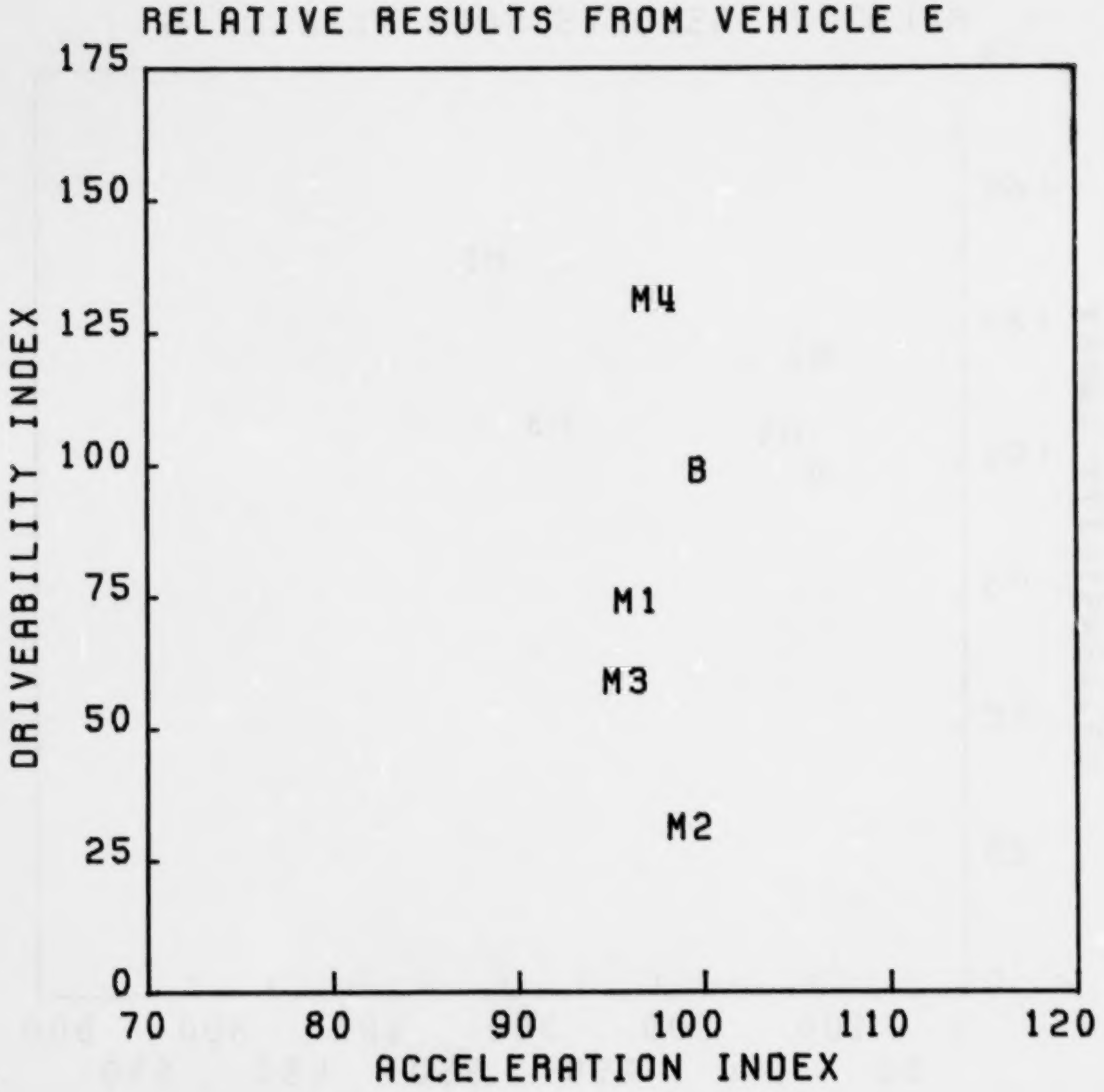

RELATIVE RESULTS FROM VEHICLE D
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
75
100
125
HFET FUEL CONSUMPTION INDEX
M1
M2
M3
M4
B

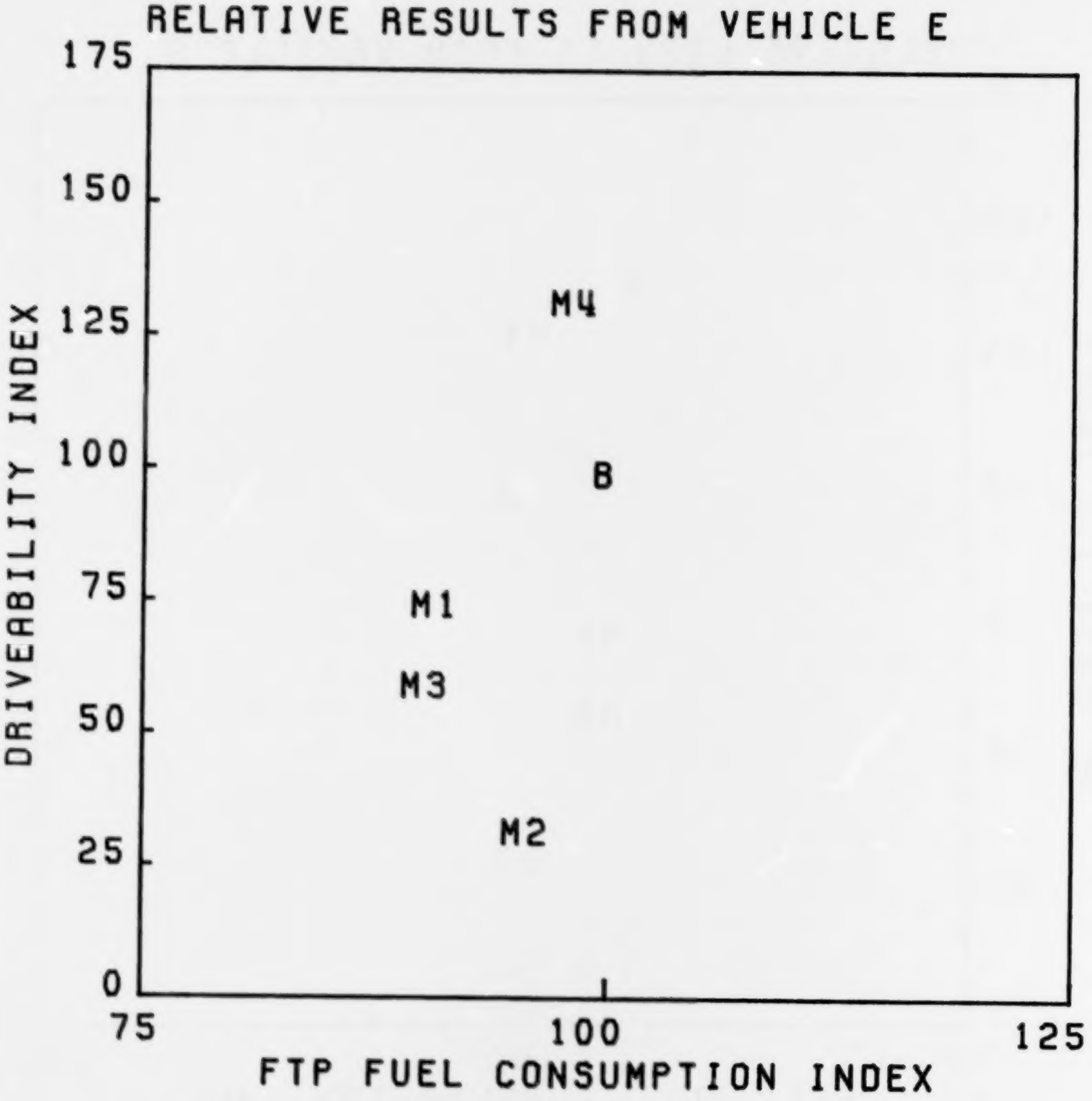

RELATIVE RESULTS FROM VEHICLE D
DRIVEABILITY INDEX
0
25
50
75
100
125
150
175
M1
M2
M3
M4
B
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX

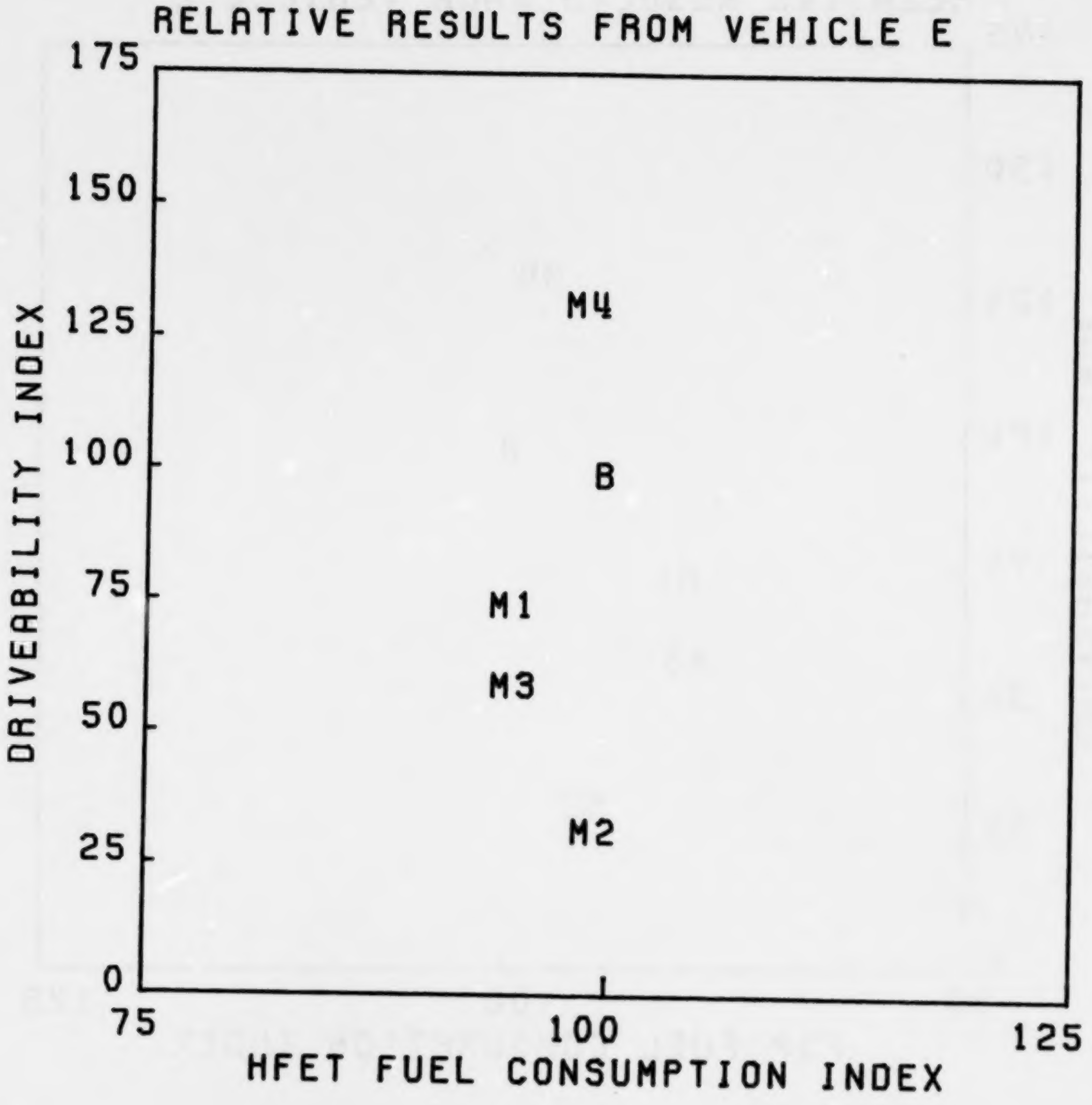

RELATIVE RESULTS FROM VEHICLE D
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M1
M2
M3
M4
B
0
300
600
900
1200
1500
CO EMISSION INDEX

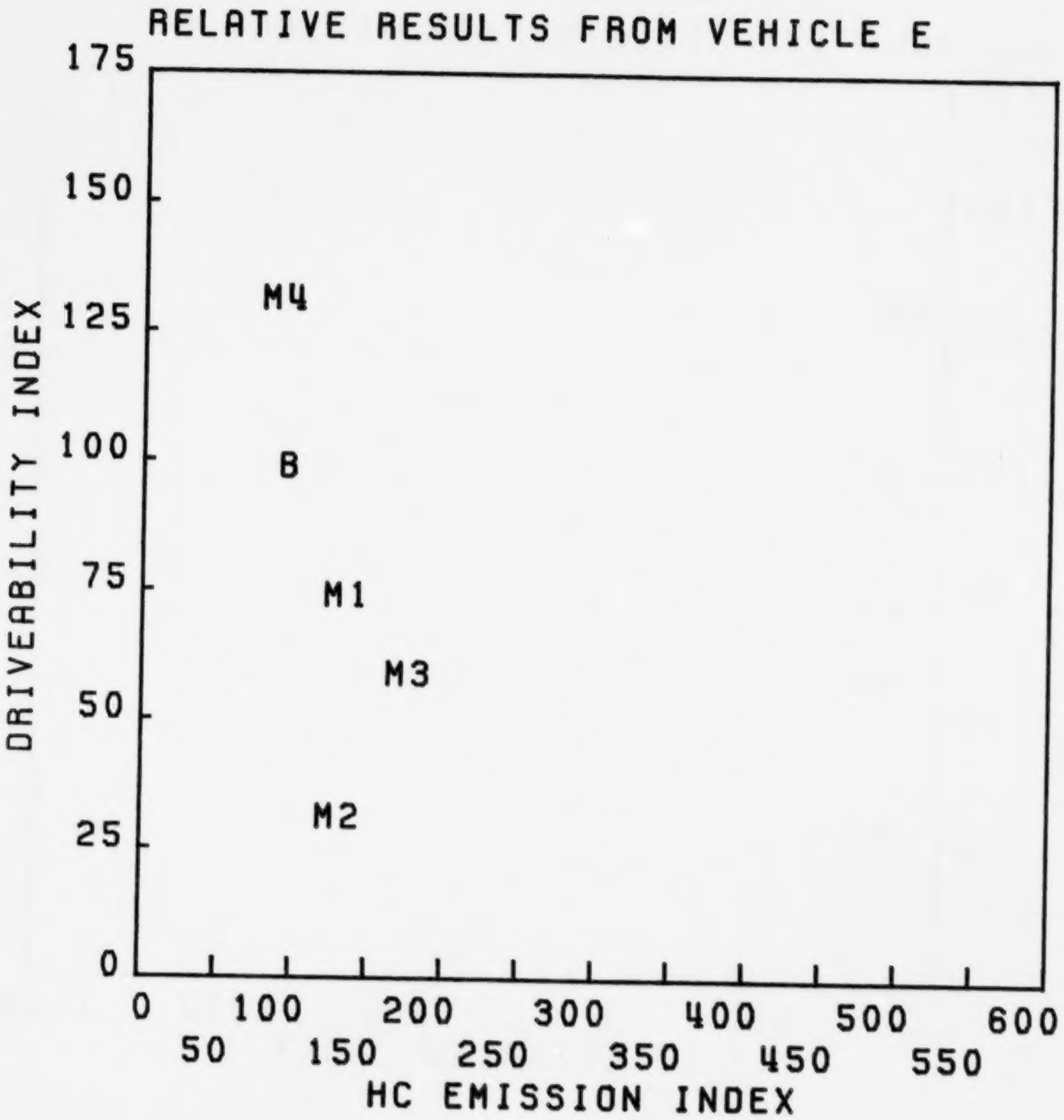


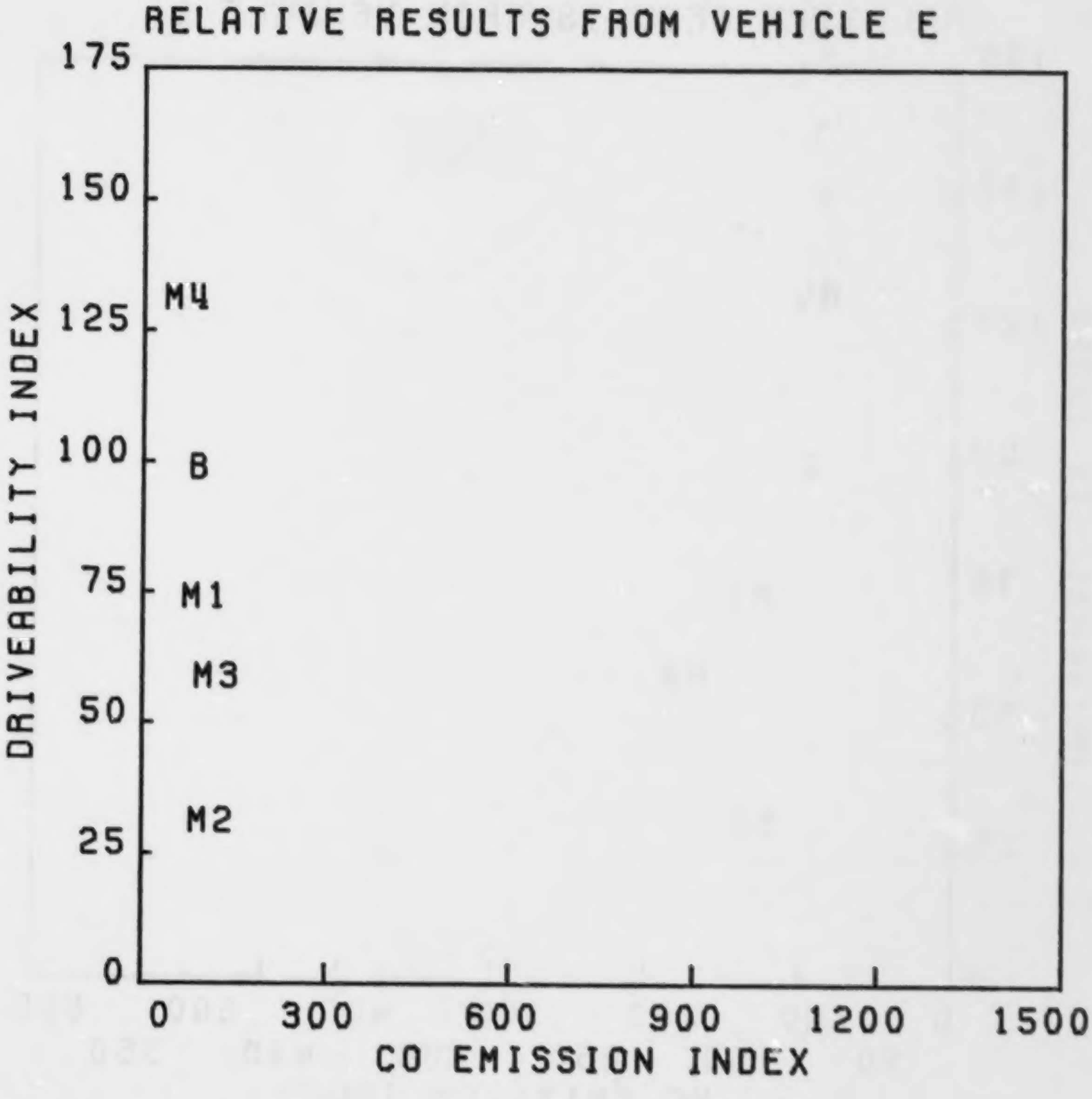
RELATIVE RESULTS FROM VEHICLE D

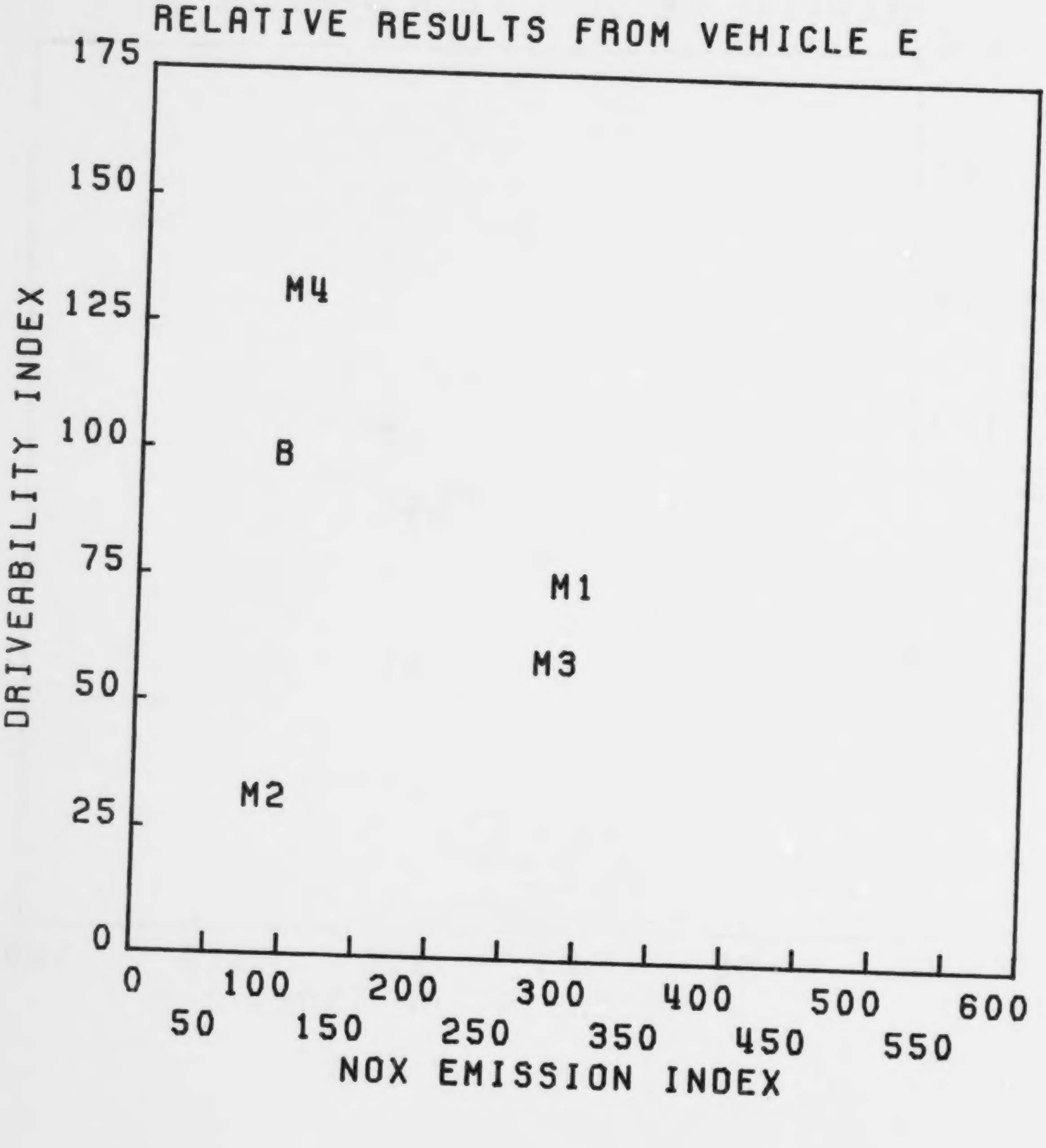

RELATIVE RESULTS FROM VEHICLE E
DRIVEABILITY INDEX
ACCELERATION INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
M4
B
M1
M3
M2

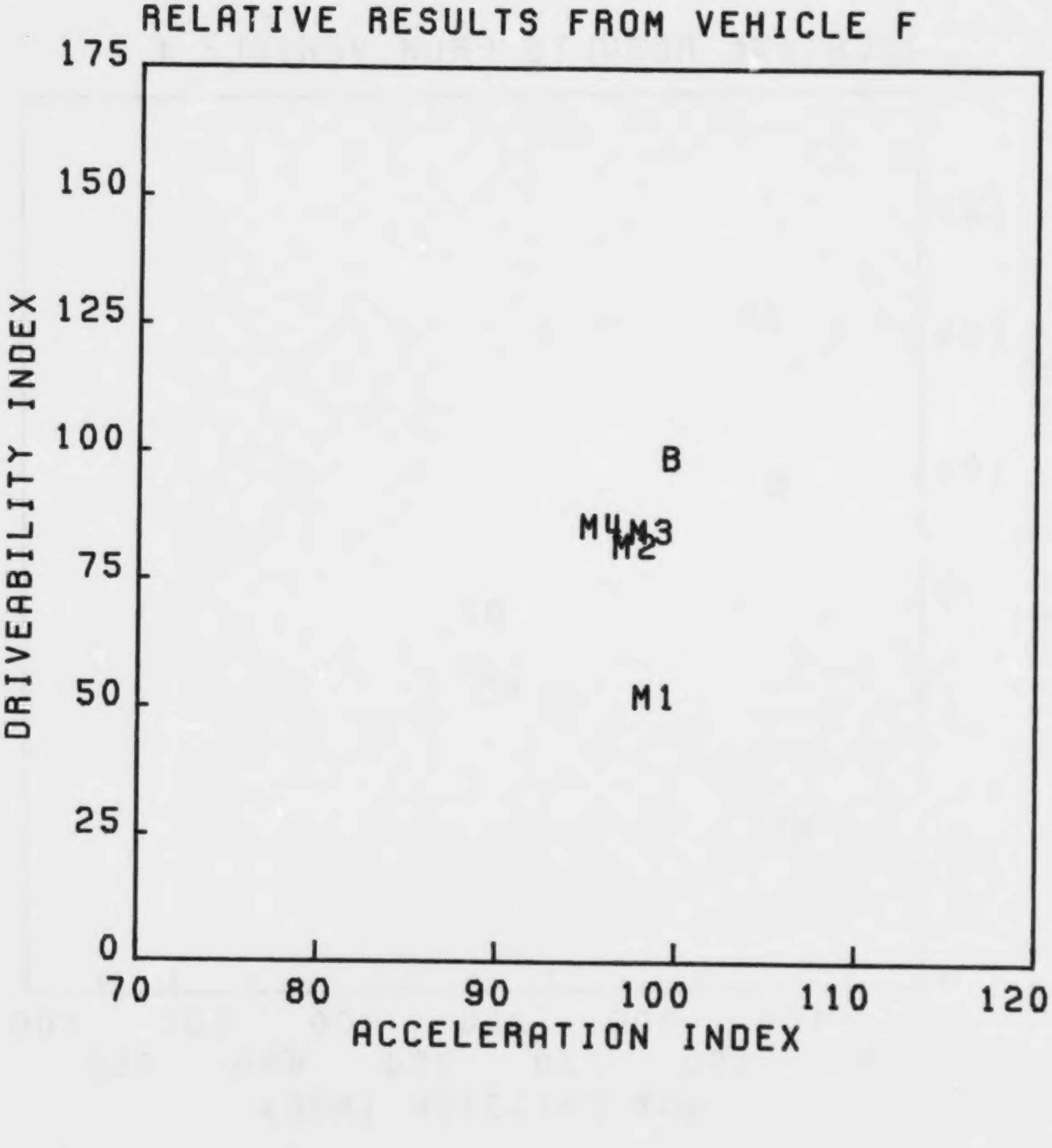

RELATIVE RESULTS FROM VEHICLE E
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M4
B
M1
M3
M2
75
100
125
FTP FUEL CONSUMPTION INDEX

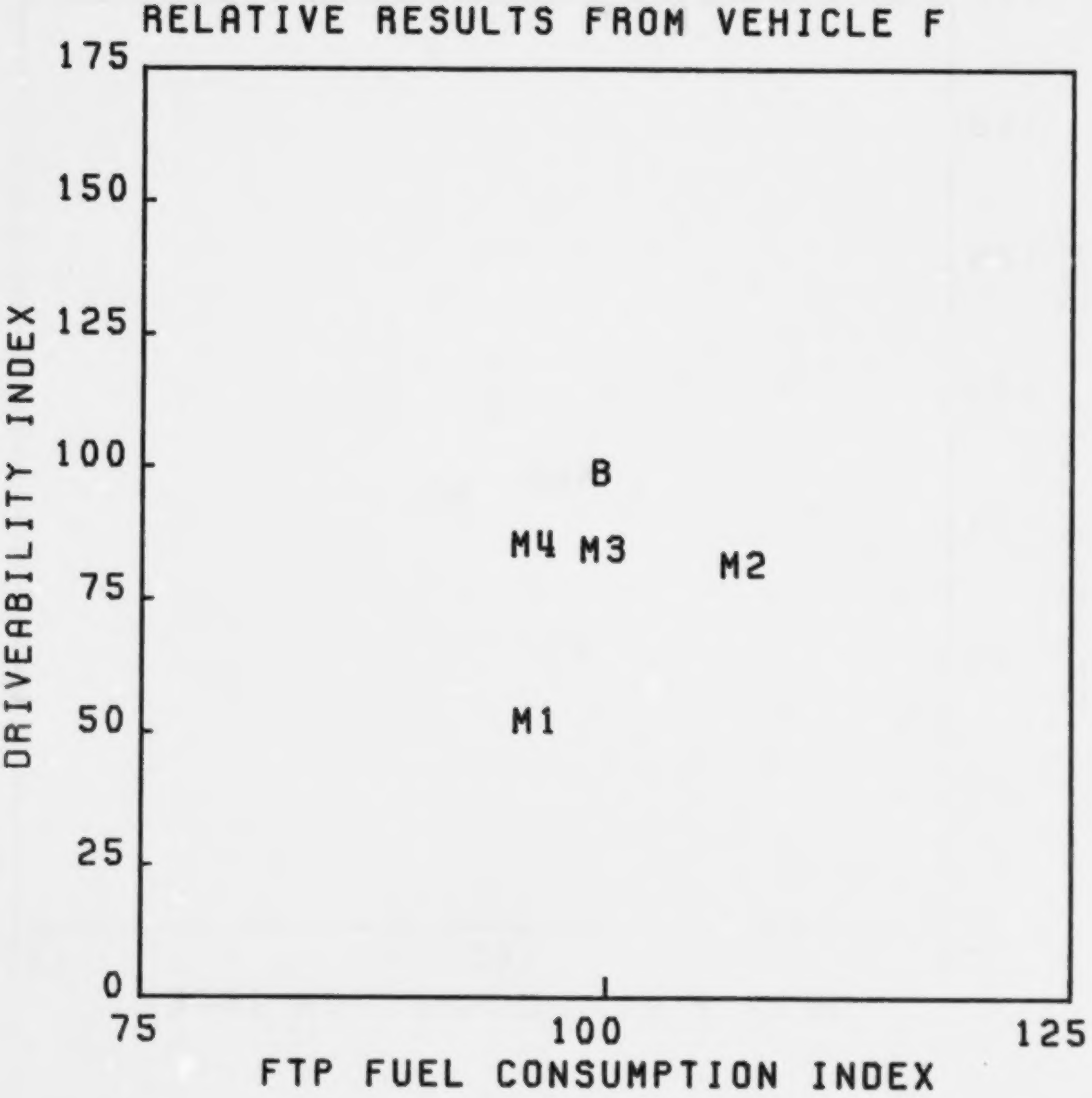

RELATIVE RESULTS FROM VEHICLE E
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M4
B
M1
M3
M2
75
100
125
HFET FUEL CONSUMPTION INDEX

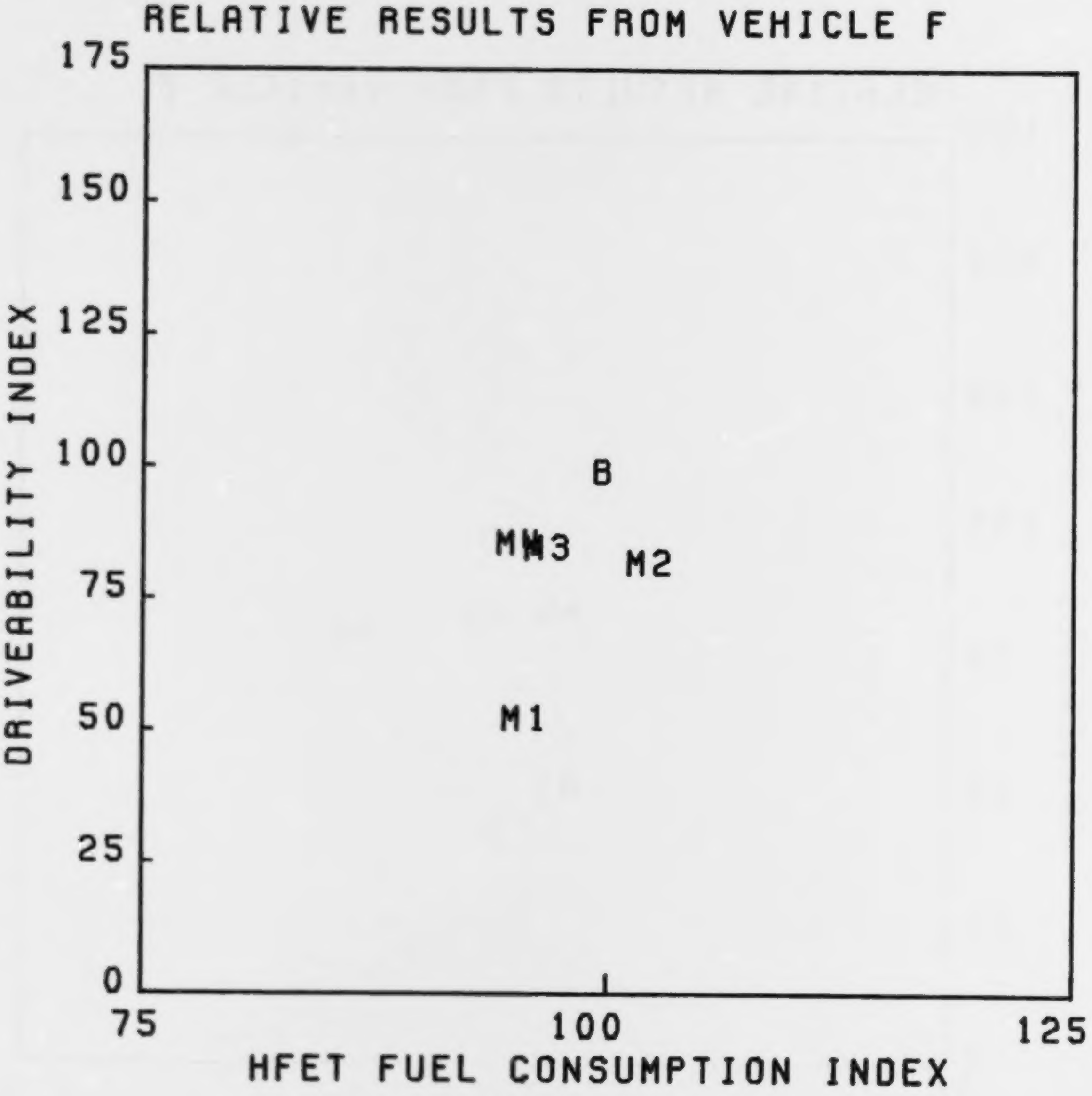

RELATIVE RESULTS FROM VEHICLE E
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M4
B
M1
M3
M2
0
100
200
300
400
500
600
50
150
250
350
450
550
HC EMISSION INDEX

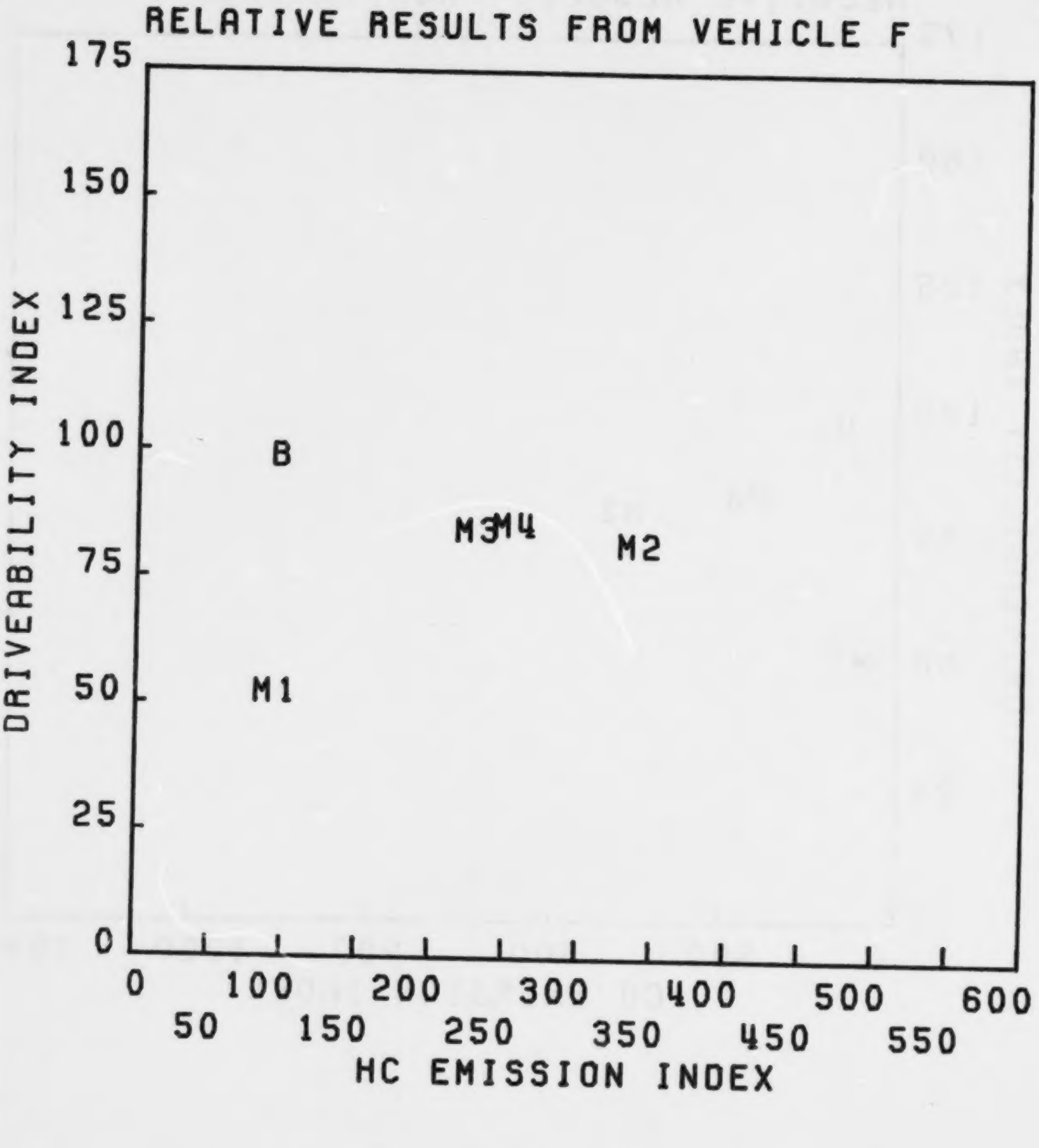

RELATIVE RESULTS FROM VEHICLE E
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M4
B
M1
M3
M2
0
300
600
900
1200
1500
CO EMISSION INDEX

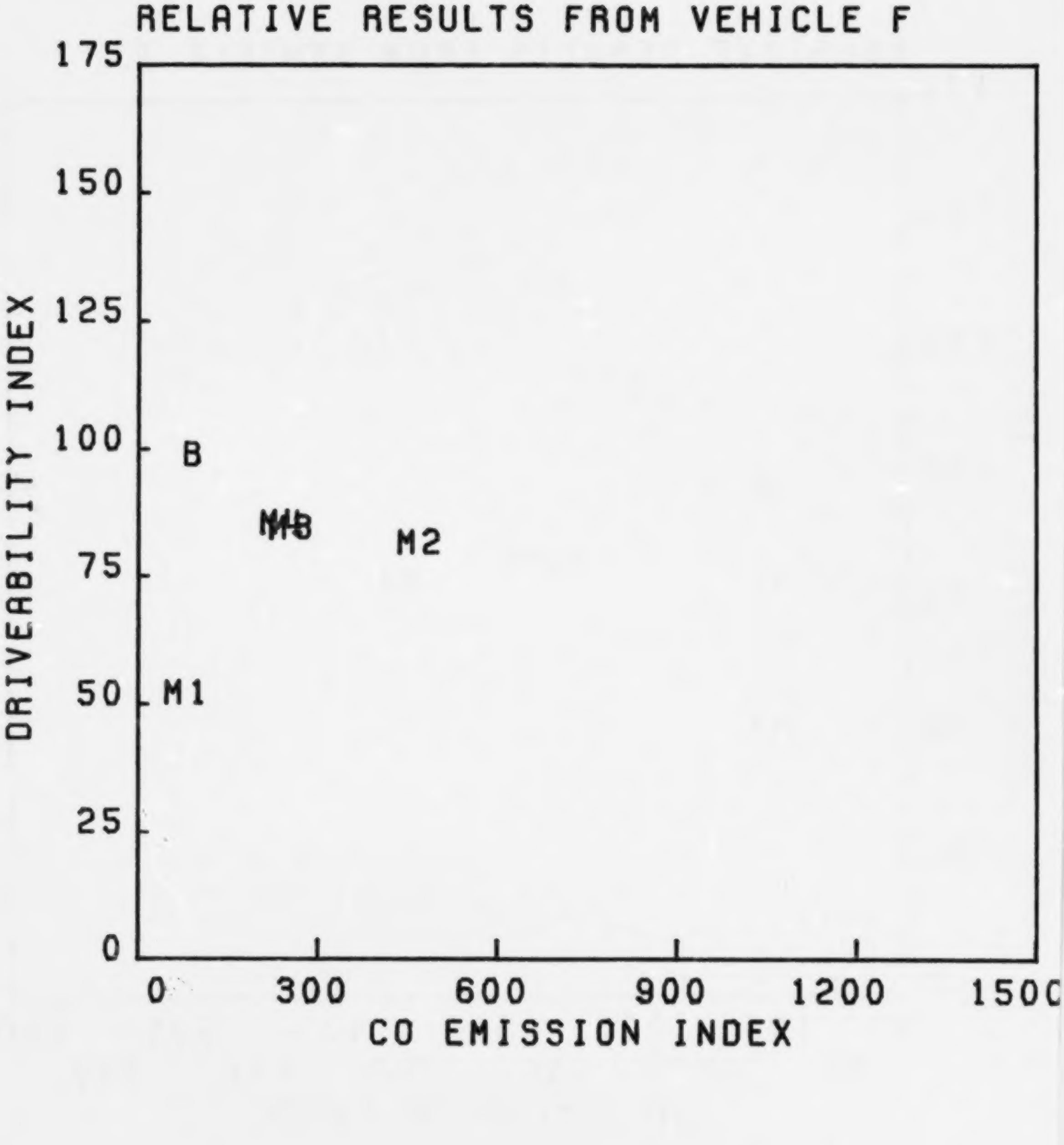

RELATIVE RESULTS FROM VEHICLE E
DRIVEABILITY INDEX
NOX EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M4
B
M1
M3
M2


RELATIVE RESULTS FROM VEHICLE F
DRIVEABILITY INDEX
ACCELERATION INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
B
M4
M3
M2
M1

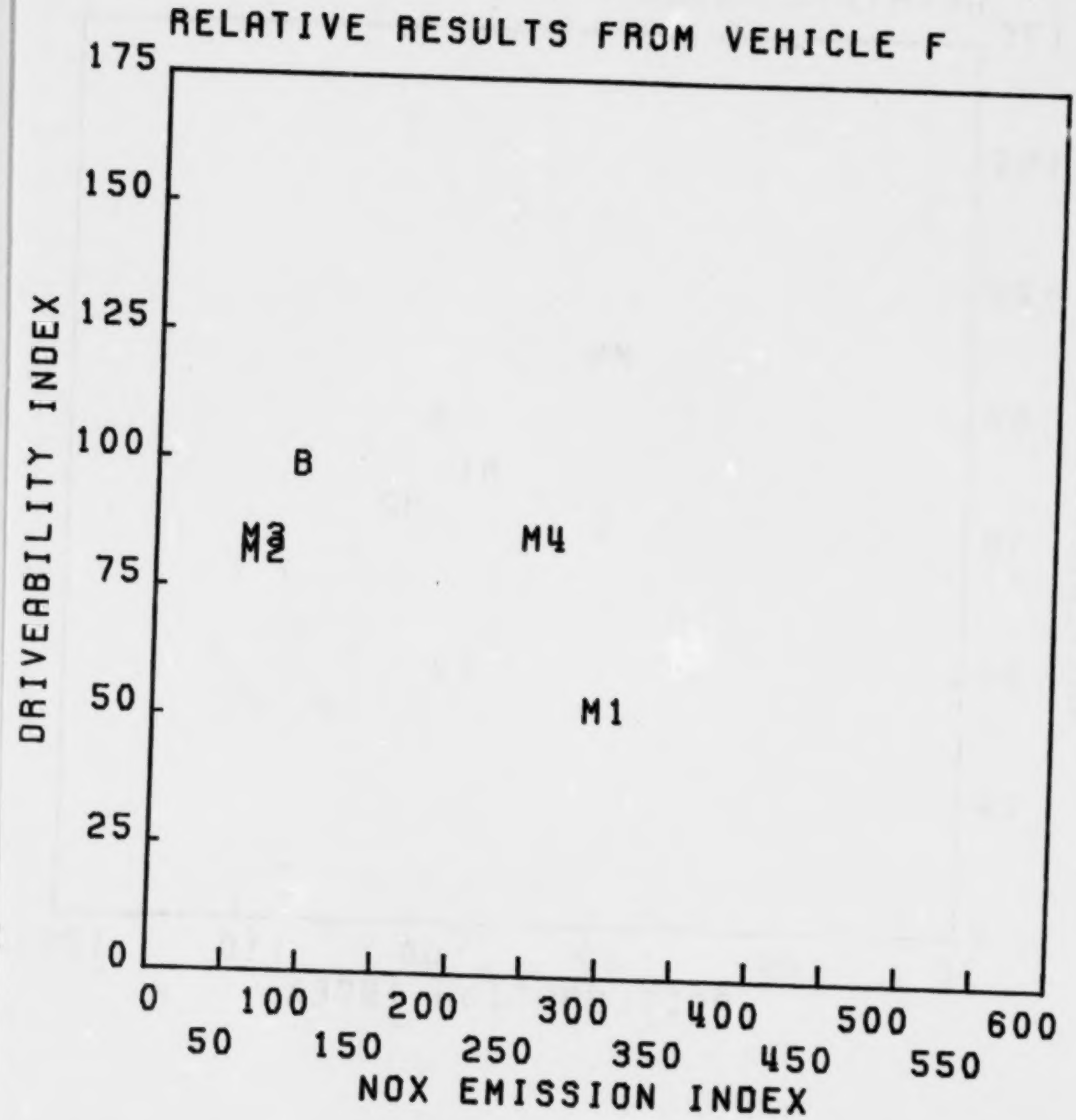

RELATIVE RESULTS FROM VEHICLE F
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M4
M3
M2
M1
75
100
125
FTP FUEL CONSUMPTION INDEX

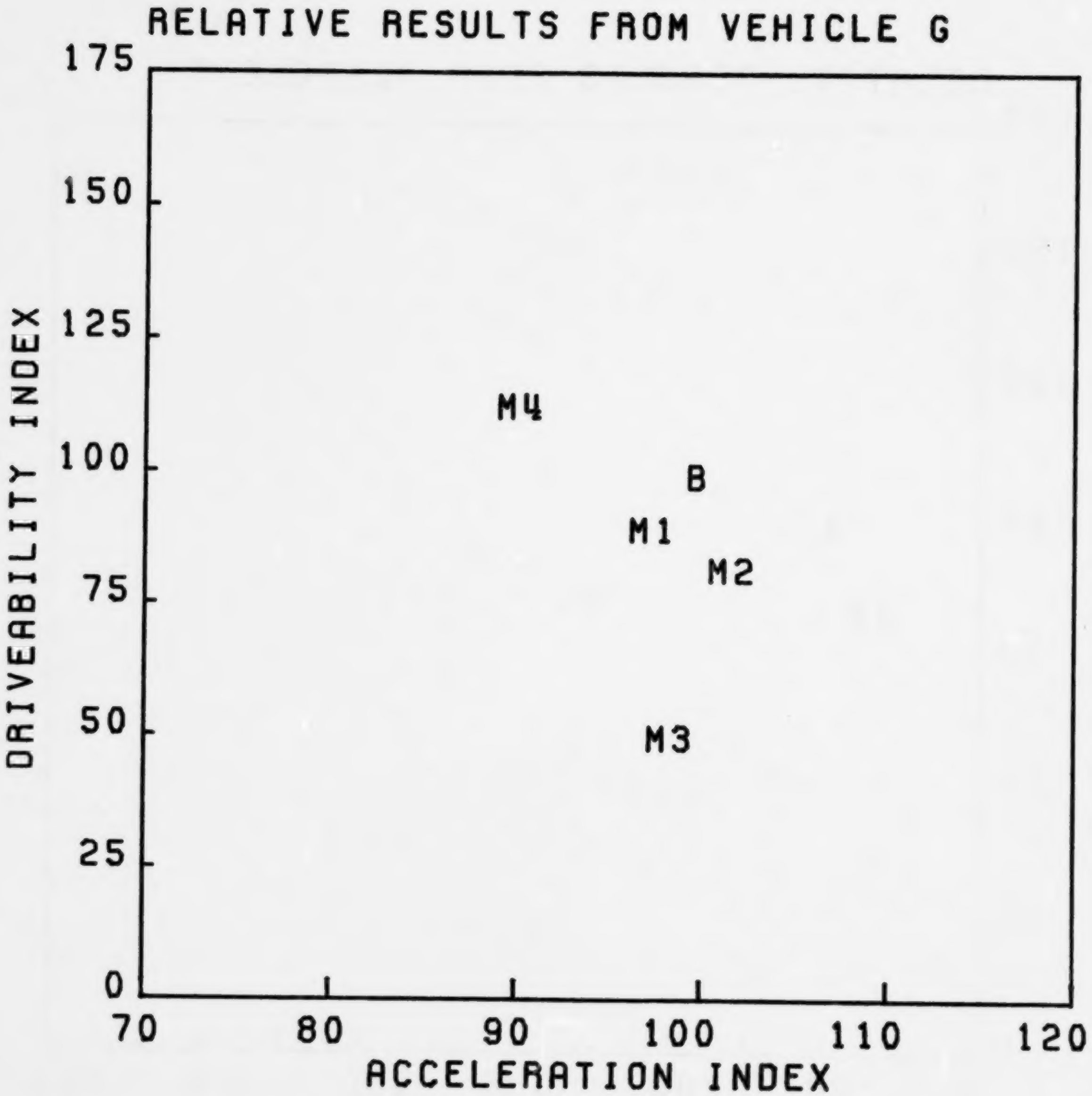
RELATIVE RESULTS FROM VEHICLE F
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
B
MM3
M2
M1
75
100
125
HFET FUEL CONSUMPTION INDEX

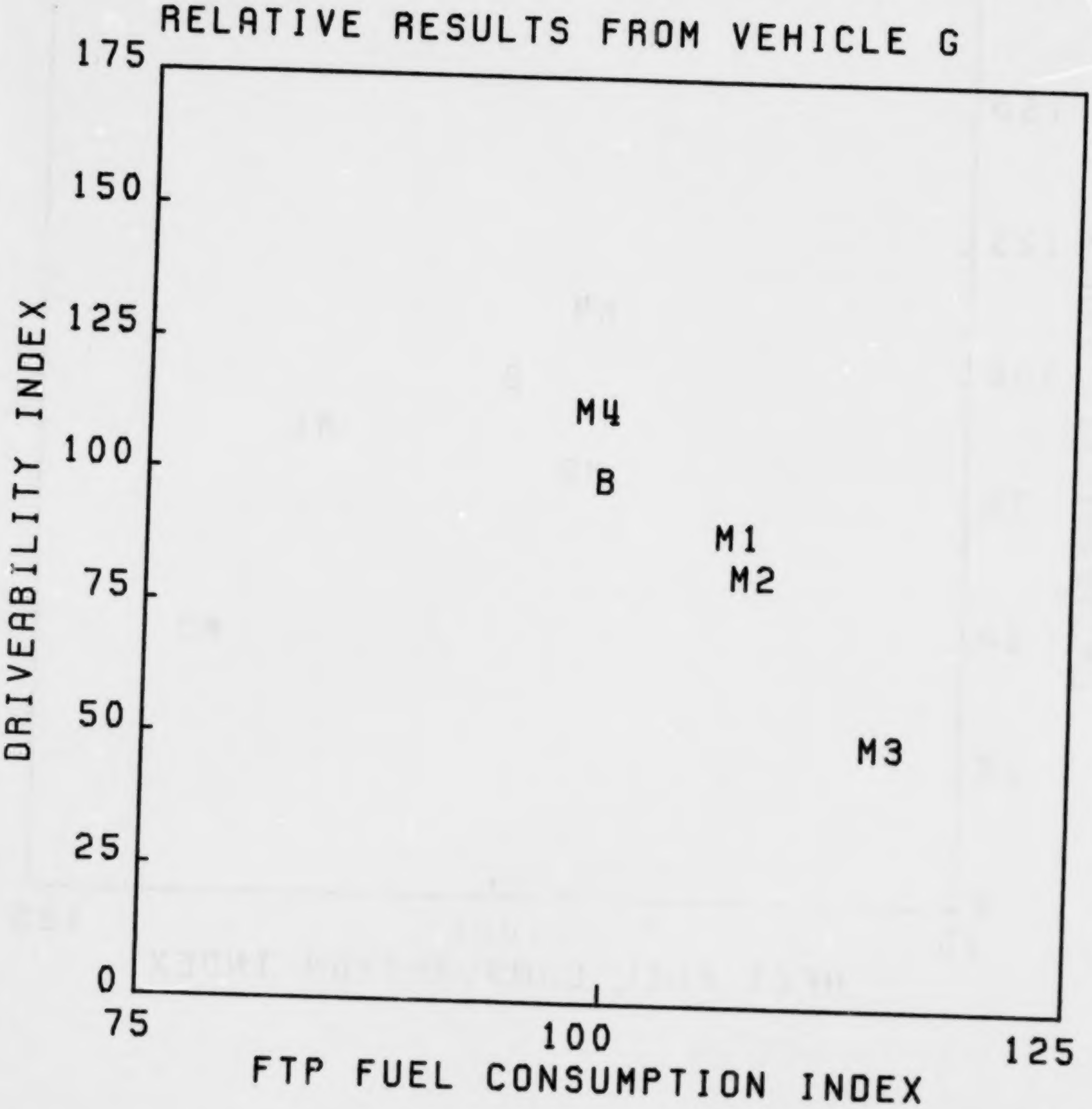

RELATIVE RESULTS FROM VEHICLE F
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
HC EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
B
M1
M3
M4
M2

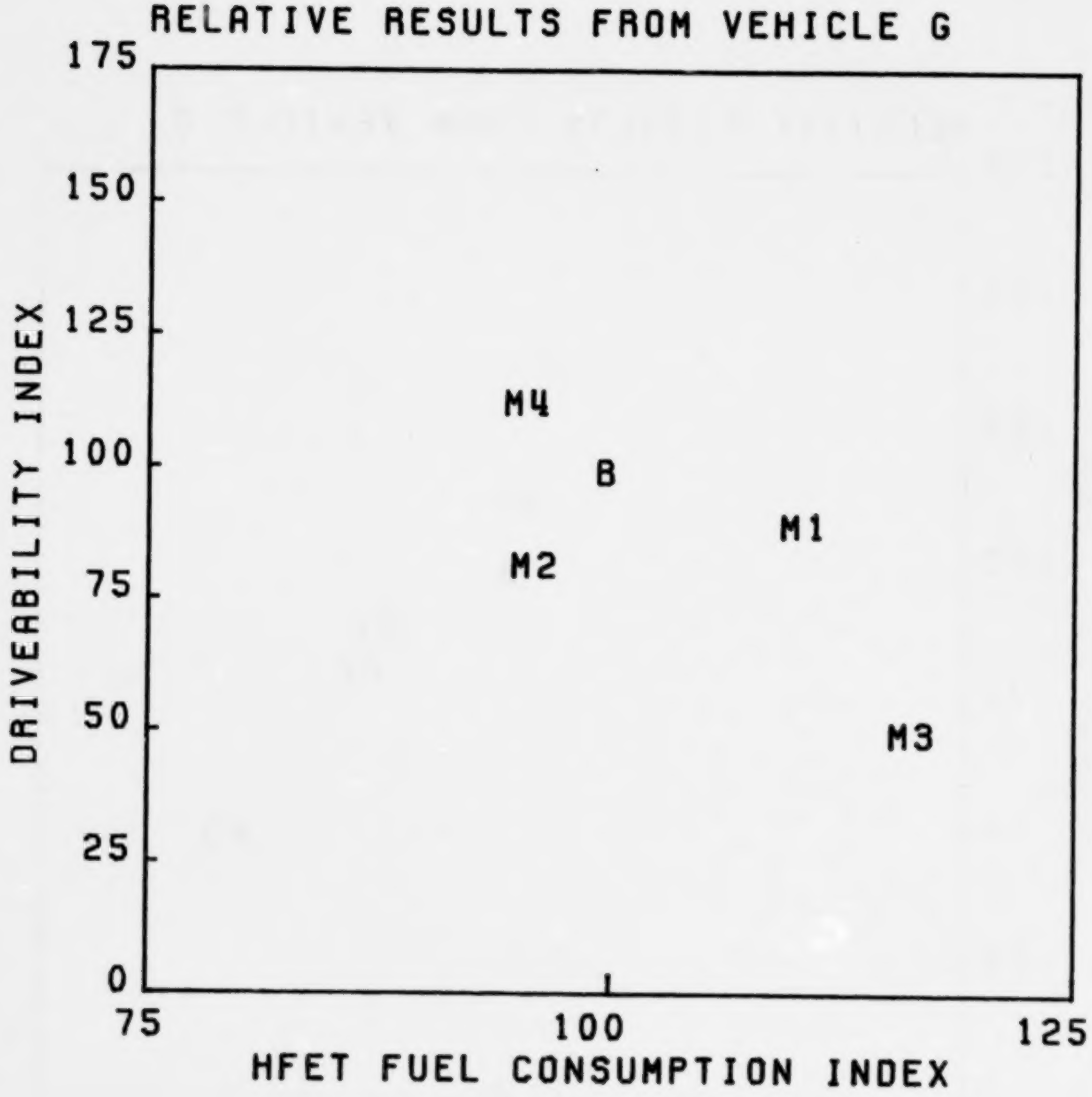


RELATIVE RESULTS FROM VEHICLE F

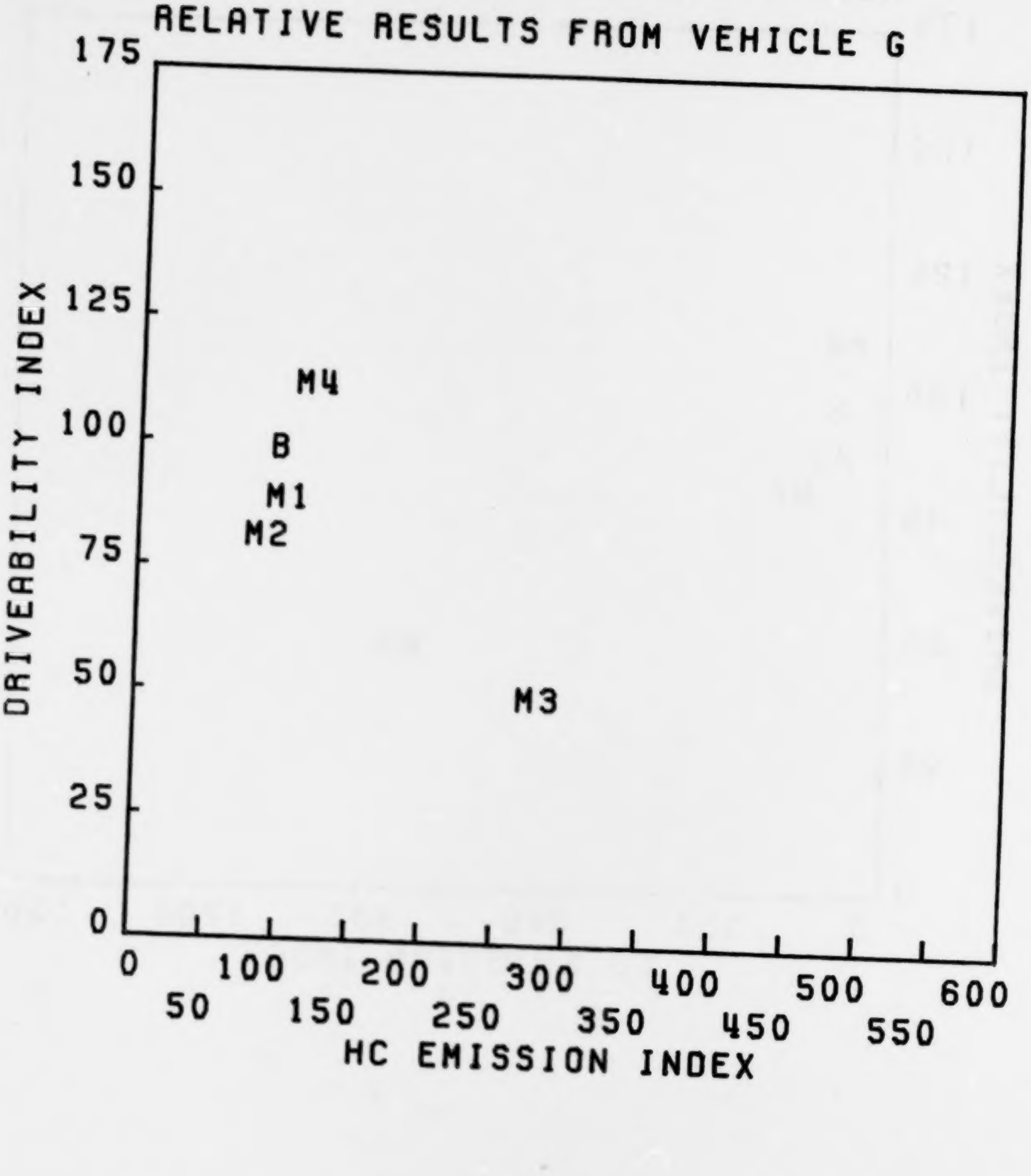

RELATIVE RESULTS FROM VEHICLE F
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX

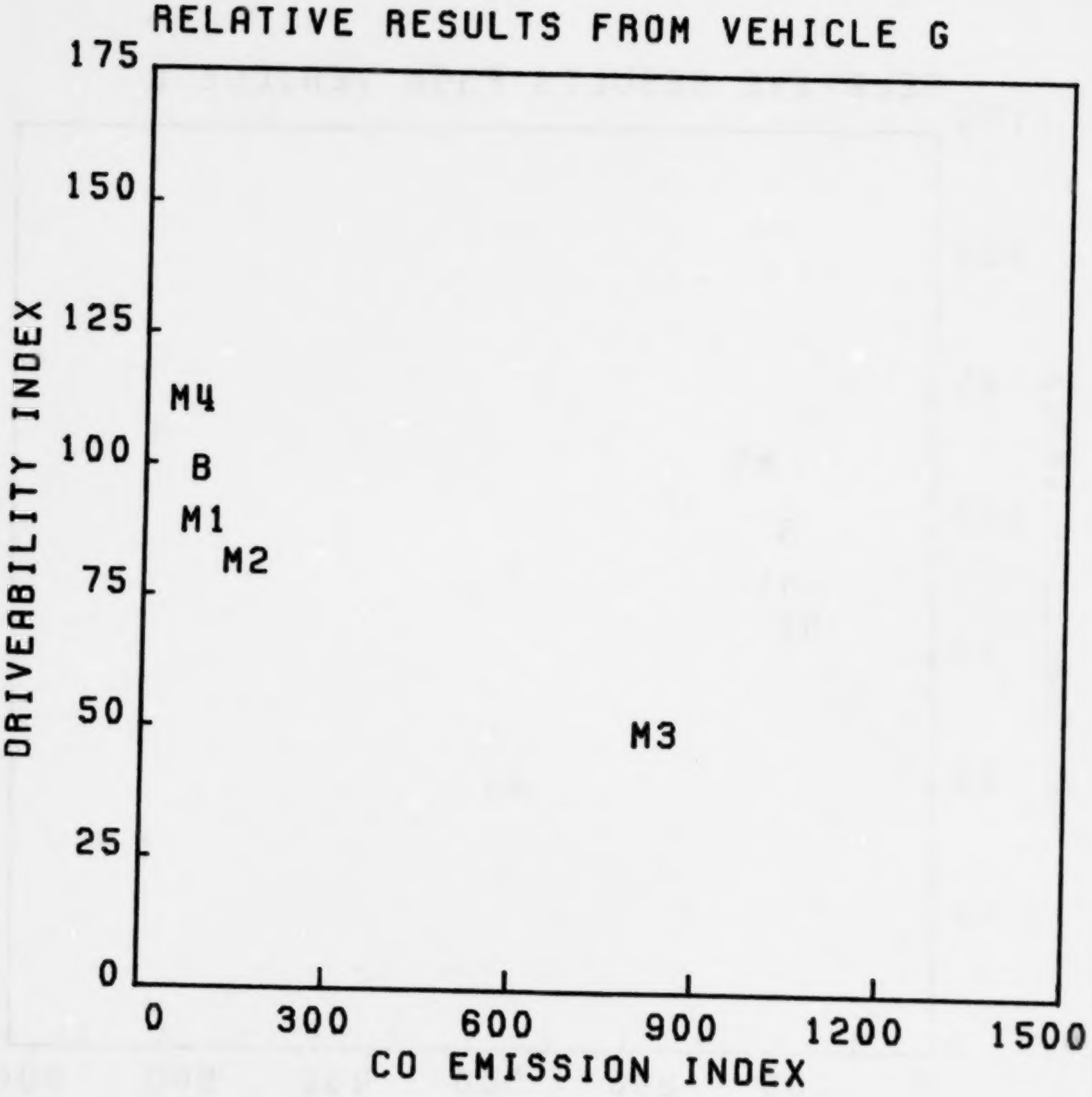

RELATIVE RESULTS FROM VEHICLE G
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
ACCELERATION INDEX
M4
B
M1
M2
M3

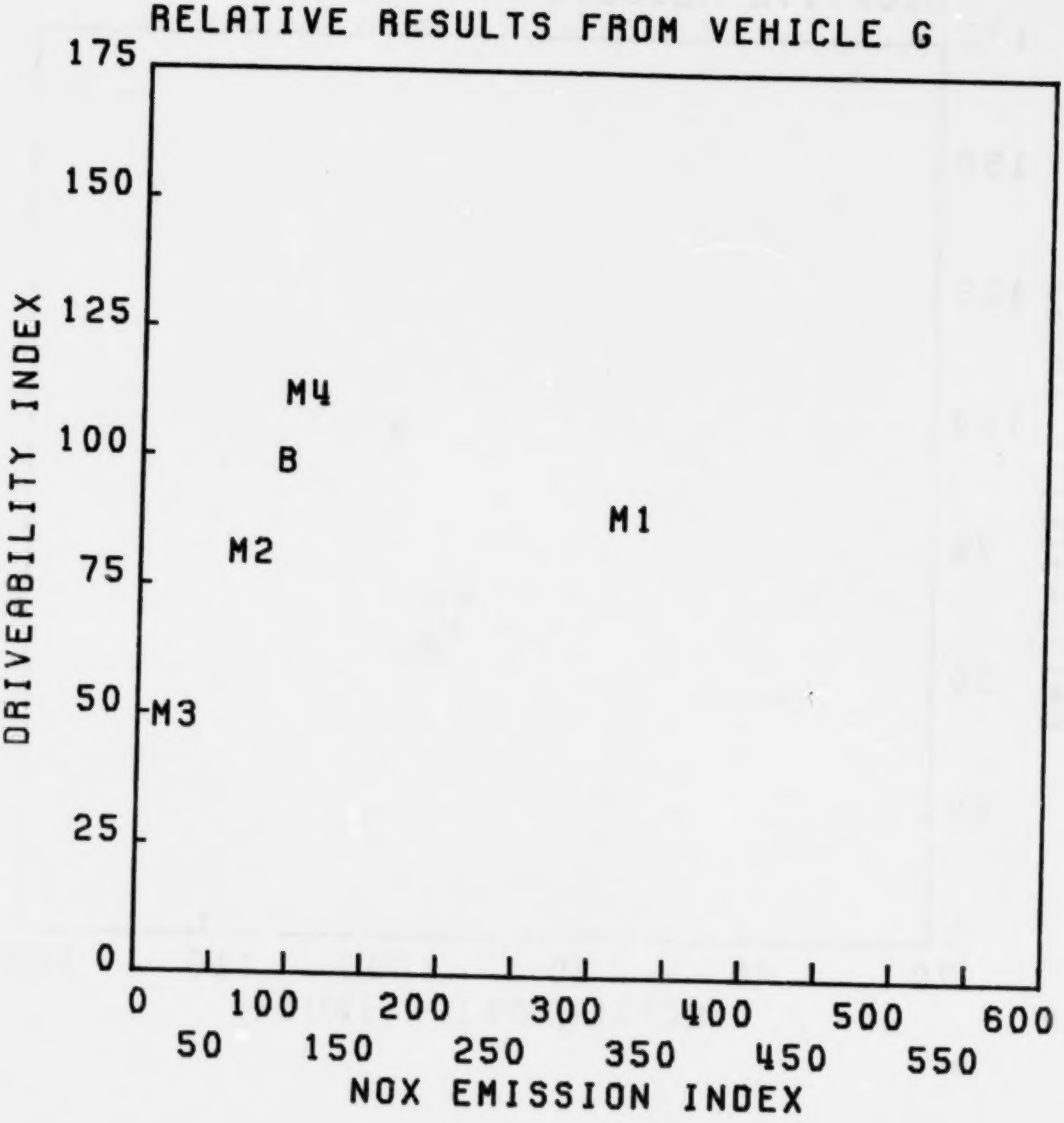

RELATIVE RESULTS FROM VEHICLE G
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M4
B
M1
M2
M3
75
100
125
FTP FUEL CONSUMPTION INDEX

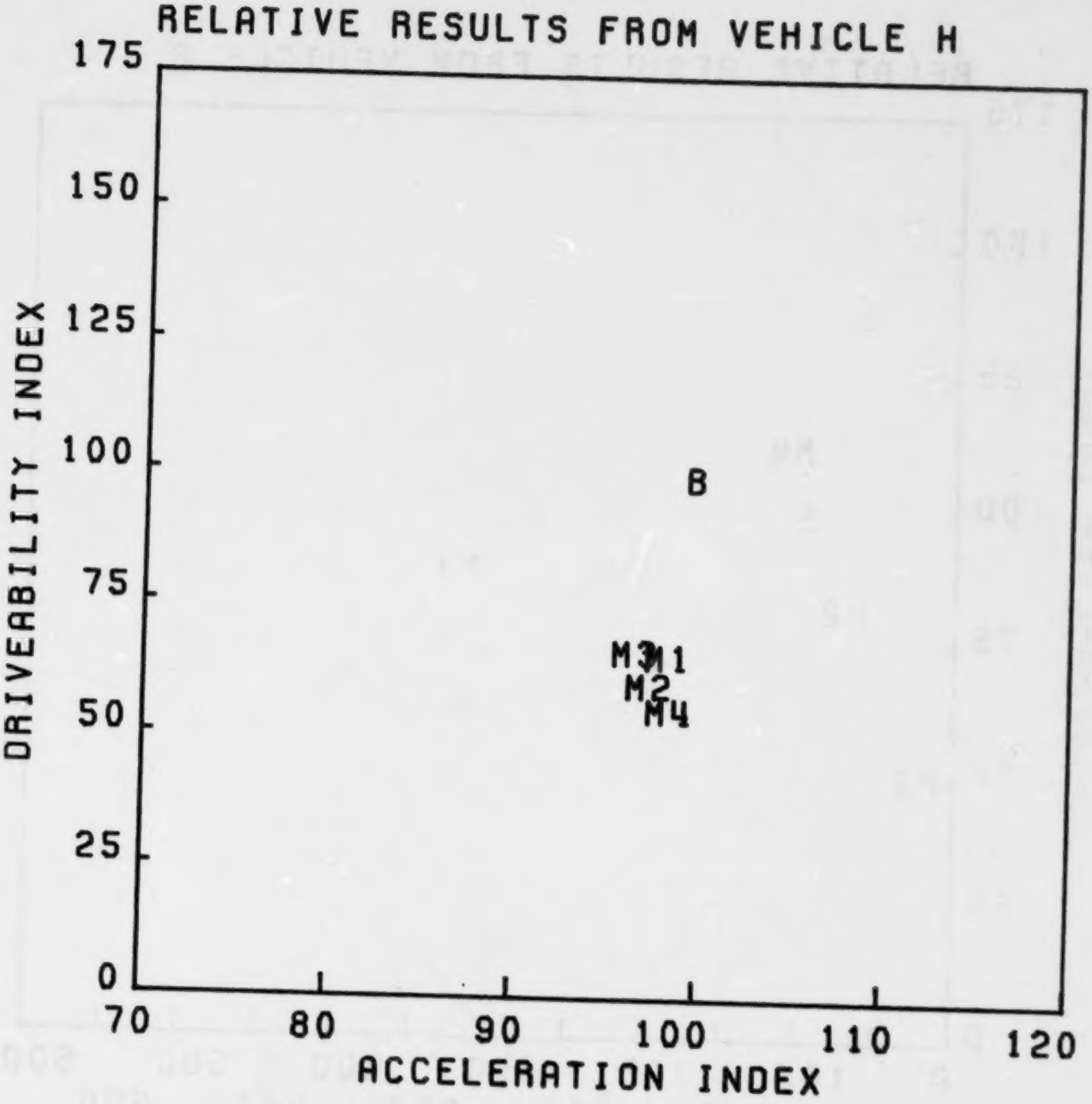


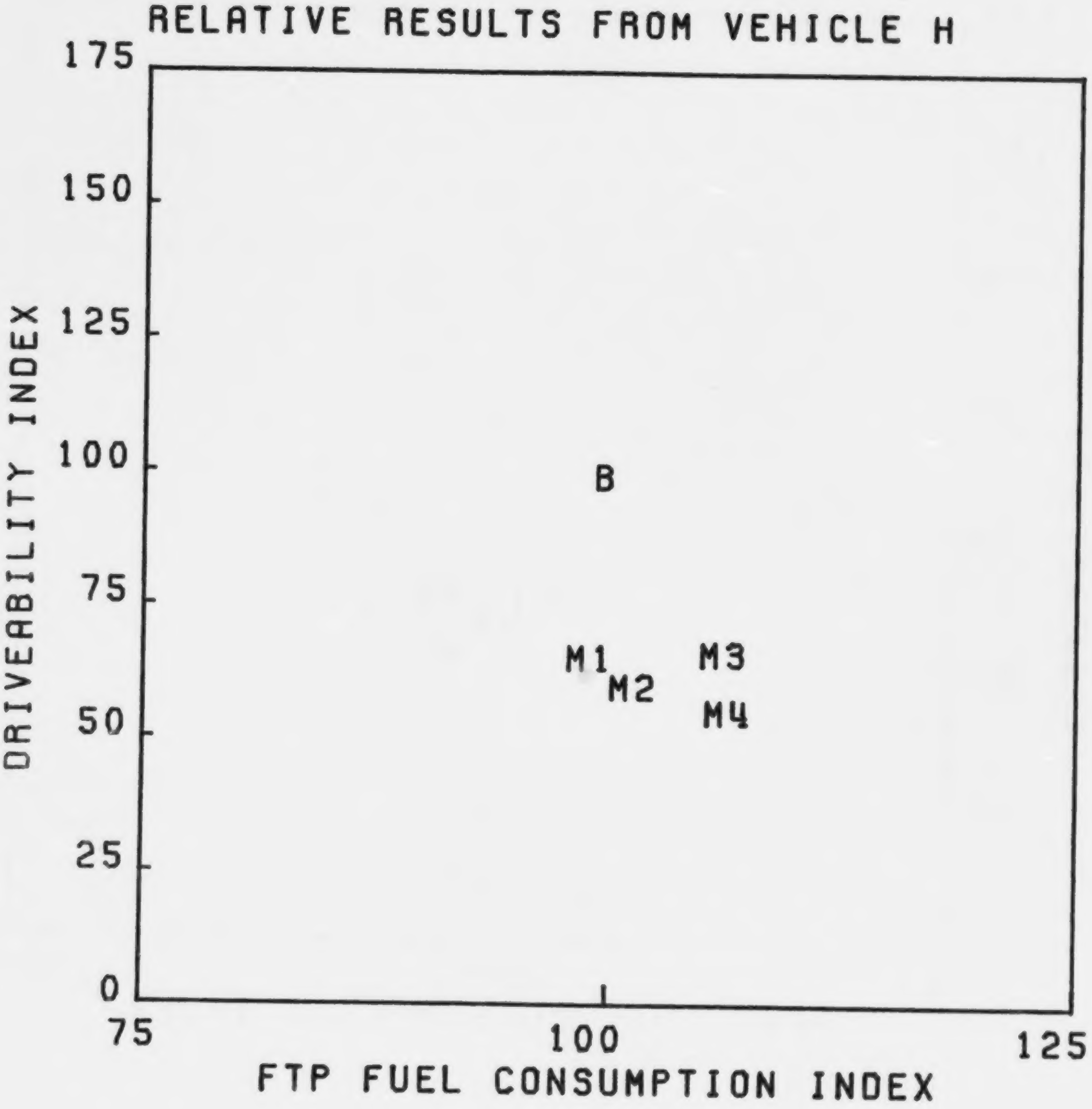
RELATIVE RESULTS FROM VEHICLE G
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M4
B
M1
M2
M3
75
100
125
HFET FUEL CONSUMPTION INDEX

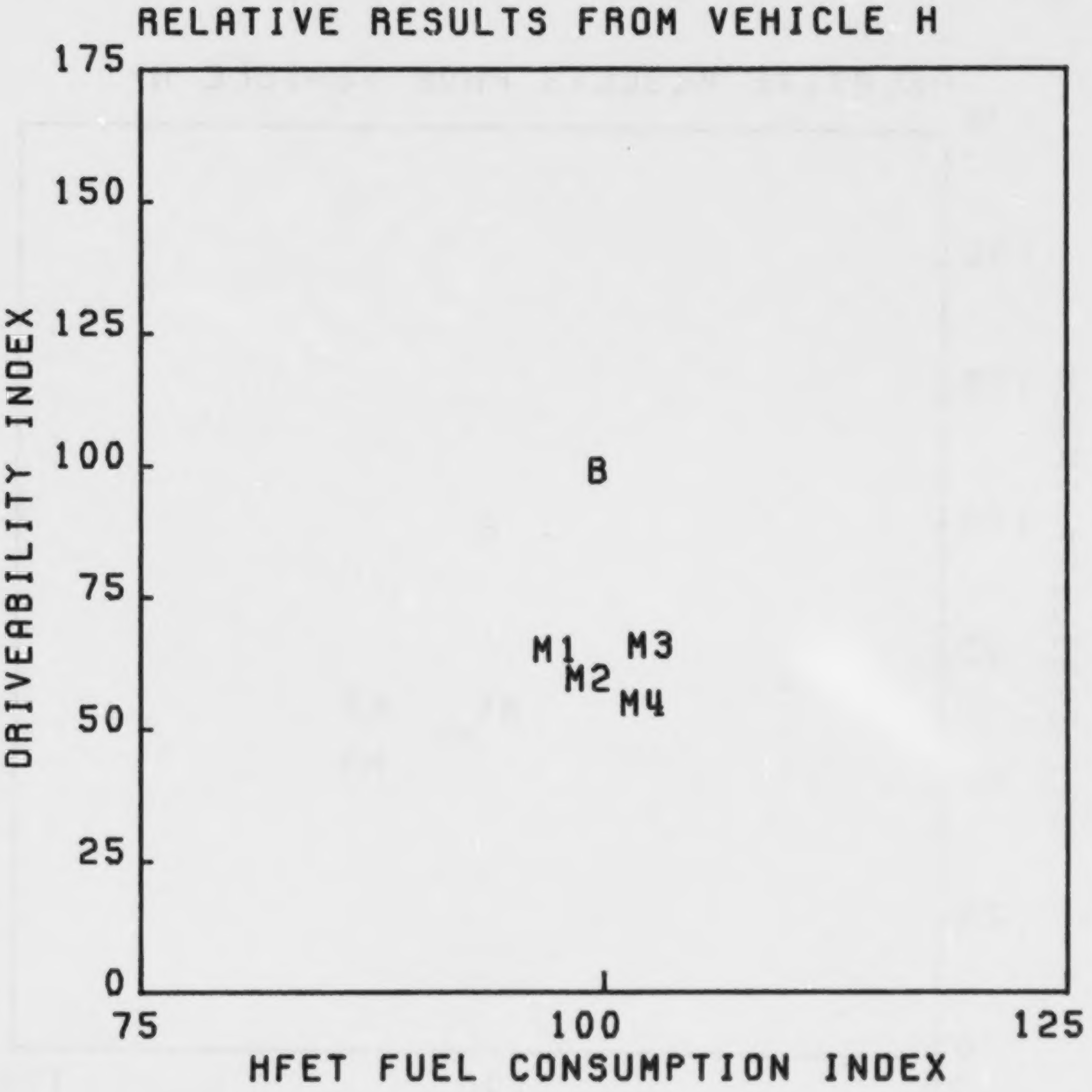

RELATIVE RESULTS FROM VEHICLE G
DRIVEABILITY INDEX
HC EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M4
B
M1
M2
M3

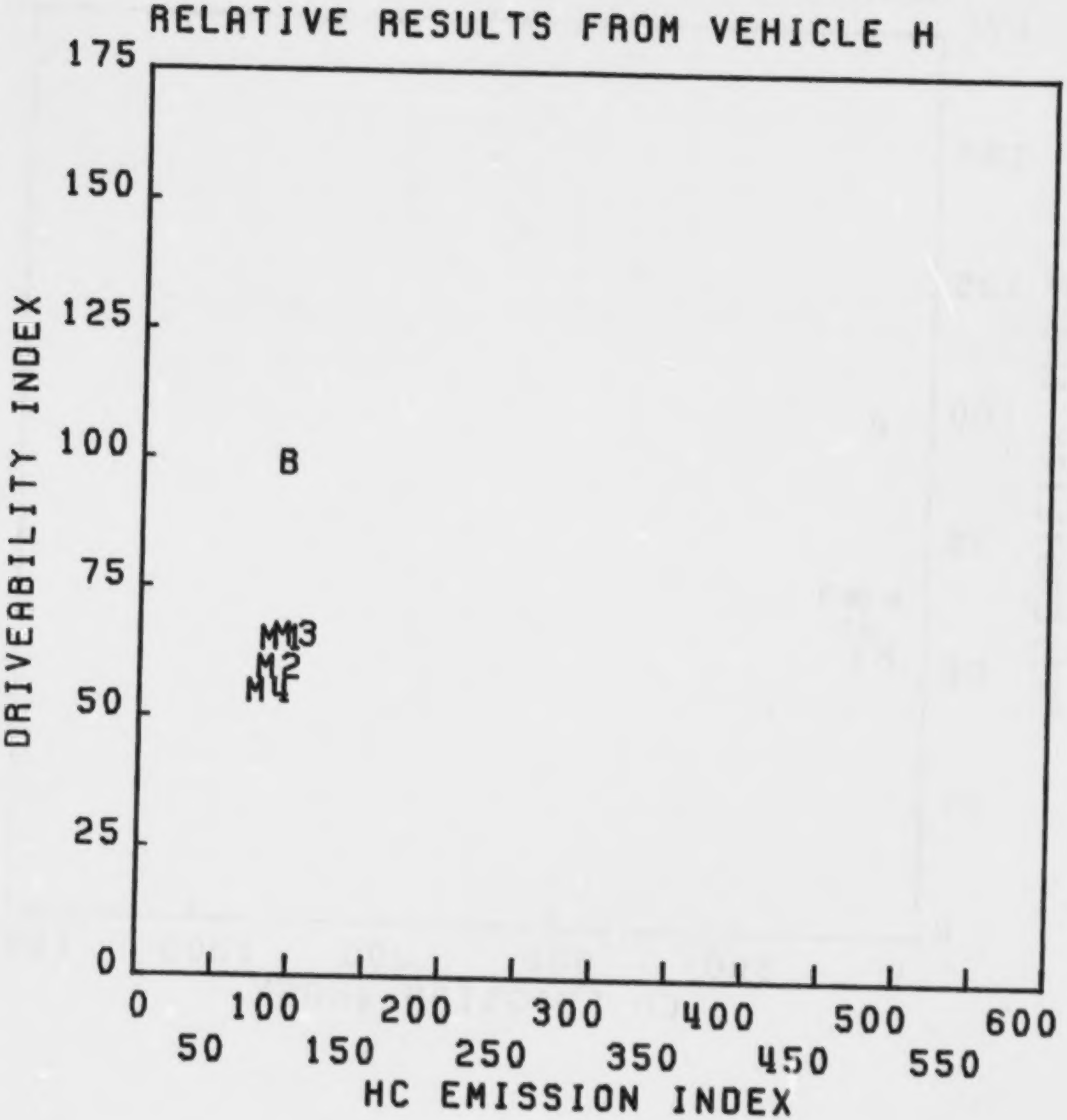

RELATIVE RESULTS FROM VEHICLE G
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M4
B
M1
M2
M3
0
300
600
900
1200
1500
CO EMISSION INDEX

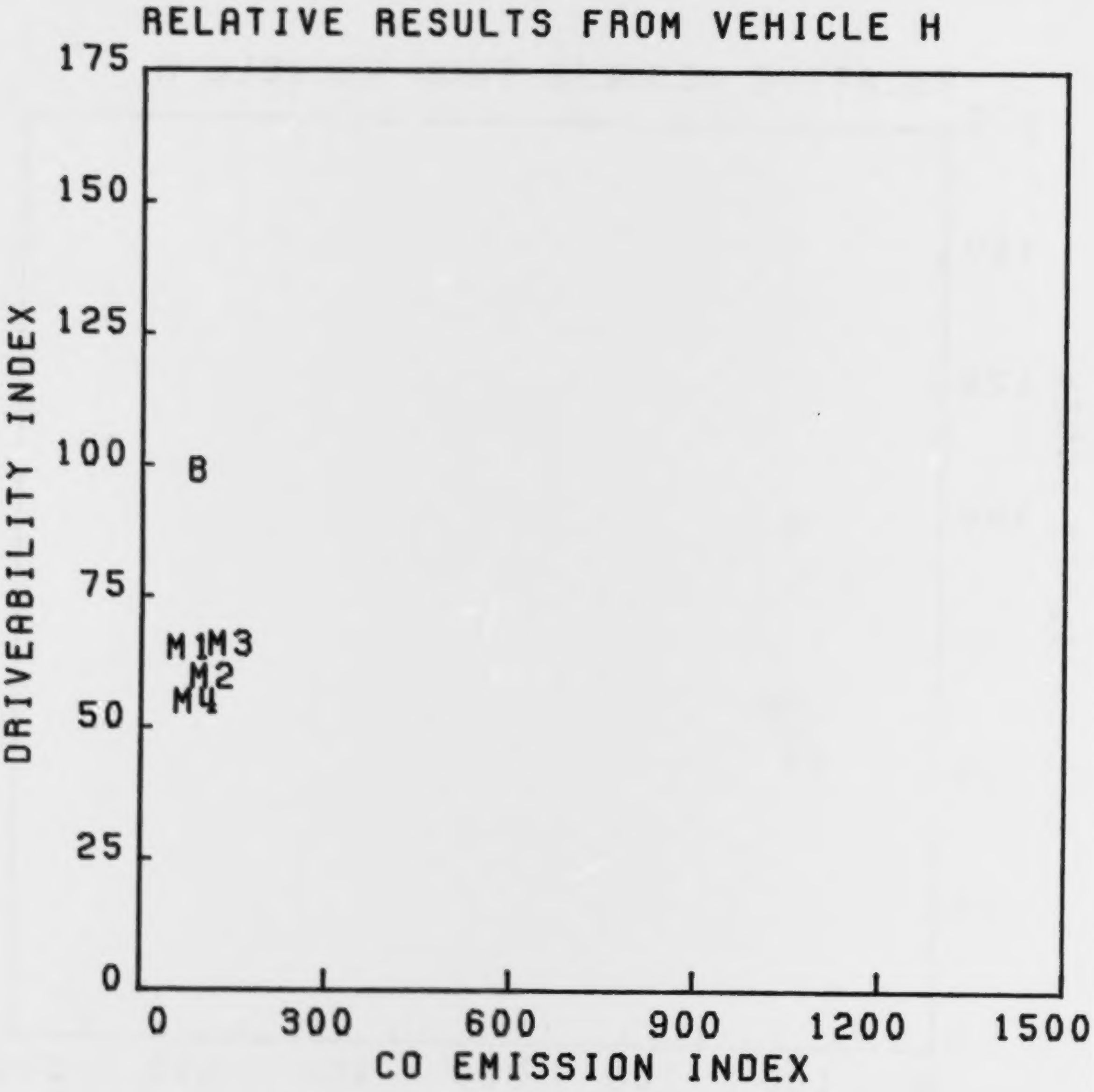

RELATIVE RESULTS FROM VEHICLE G
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M4
B
M1
M2
M3
0
100
200
300
400
500
600
50
150
250
350
450
550
NOX EMISSION INDEX

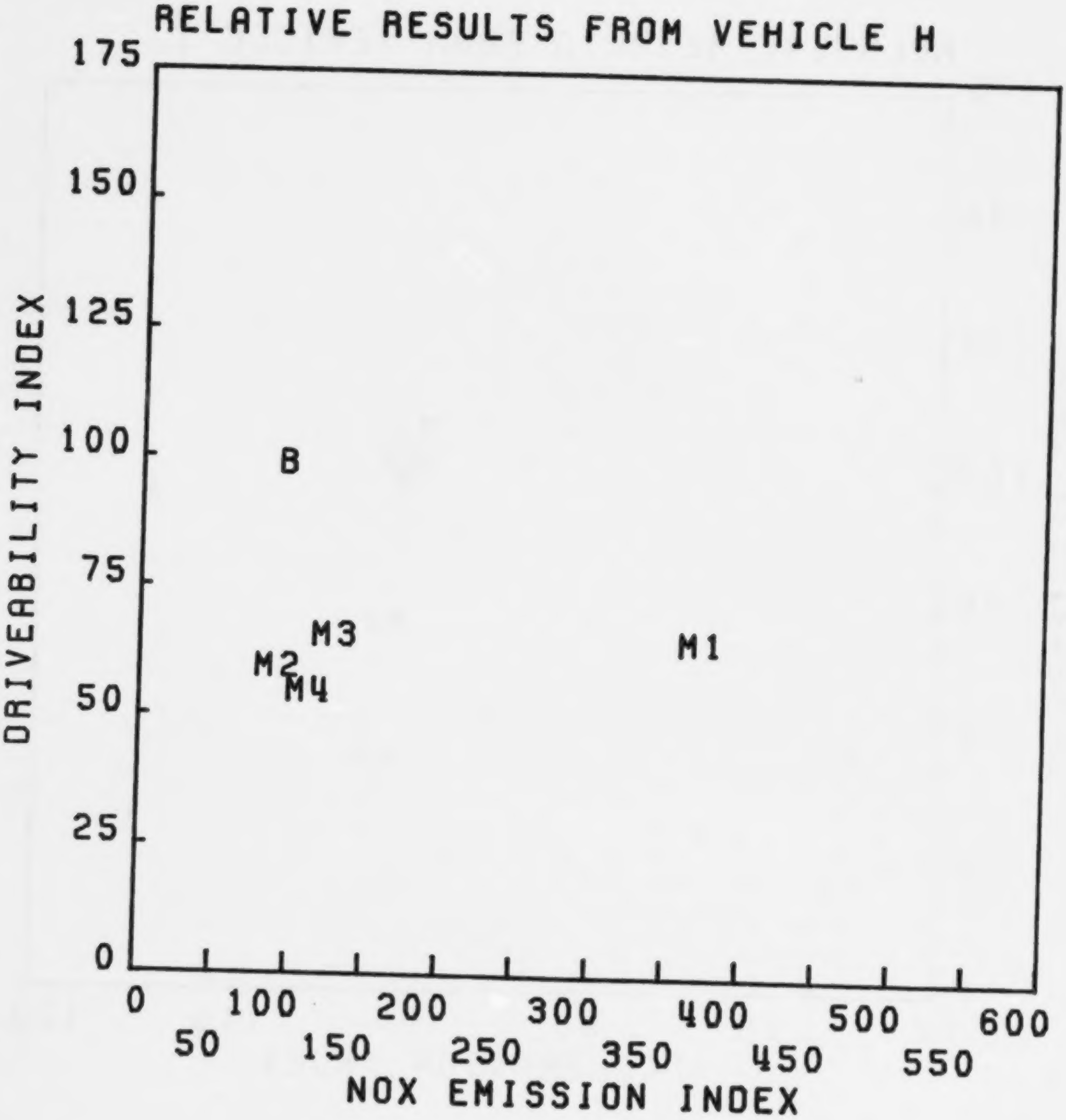

RELATIVE RESULTS FROM VEHICLE H
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
70
80
90
100
110
120
ACCELERATION INDEX
B
M3
M1
M2
M4

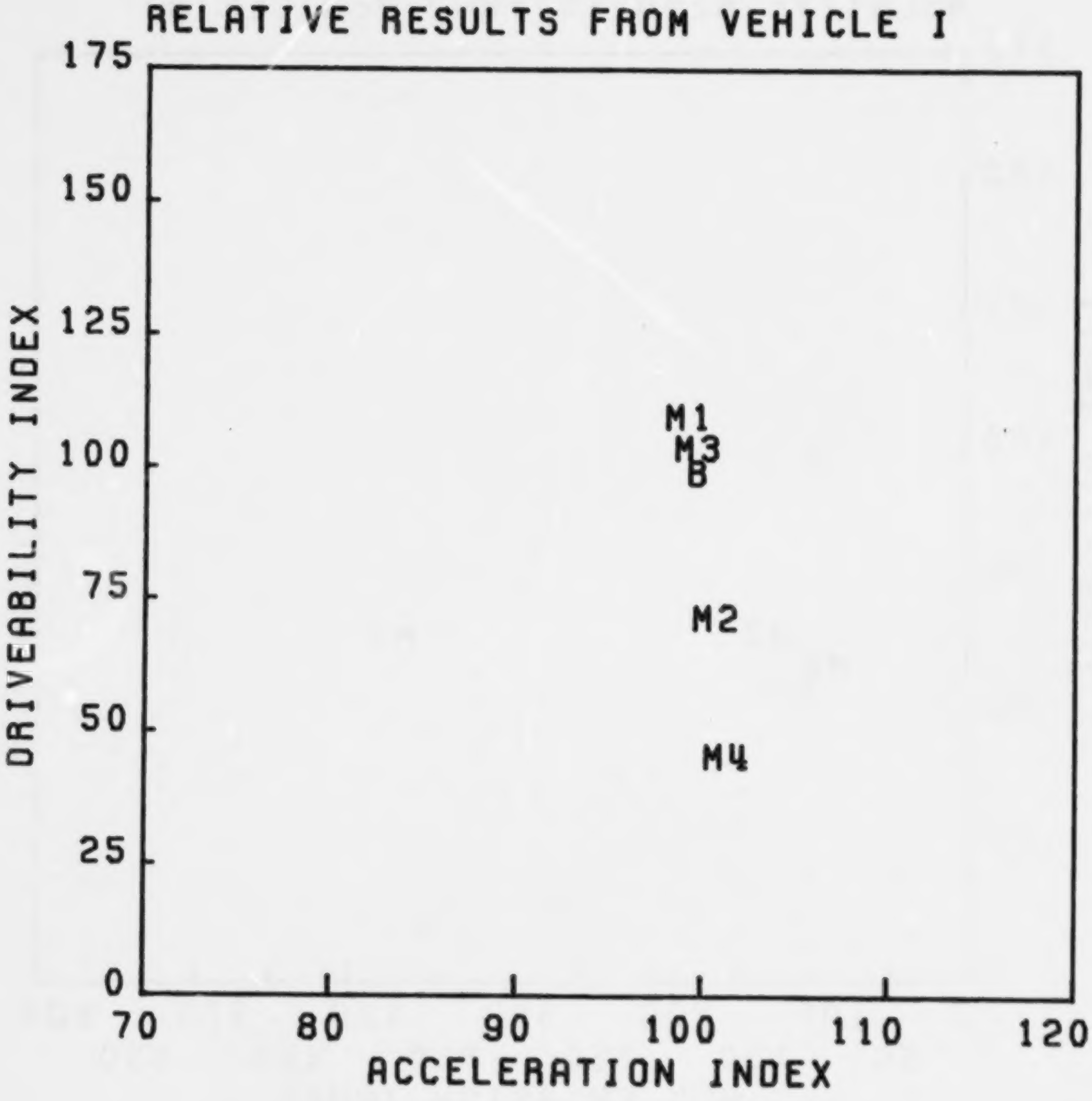

RELATIVE RESULTS FROM VEHICLE H
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M1
M2
M3
M4
75
100
125
FTP FUEL CONSUMPTION INDEX


RELATIVE RESULTS FROM VEHICLE H
DRIVEABILITY INDEX
HFET FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
B
M1
M2
M3
M4

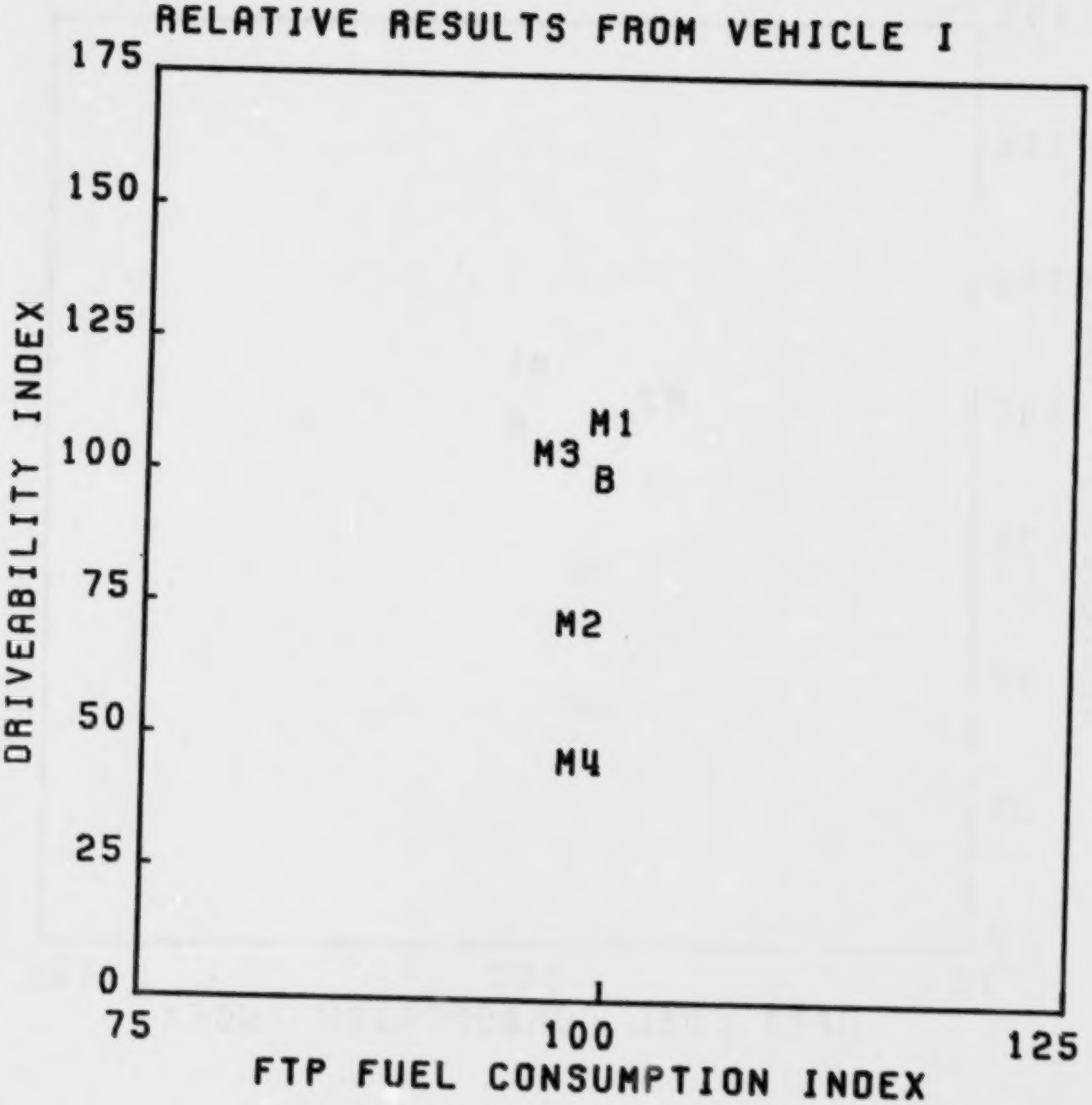

RELATIVE RESULTS FROM VEHICLE H
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M1
M3
M2
M4
0
100
200
300
400
500
600
50
150
250
350
450
550
HC EMISSION INDEX

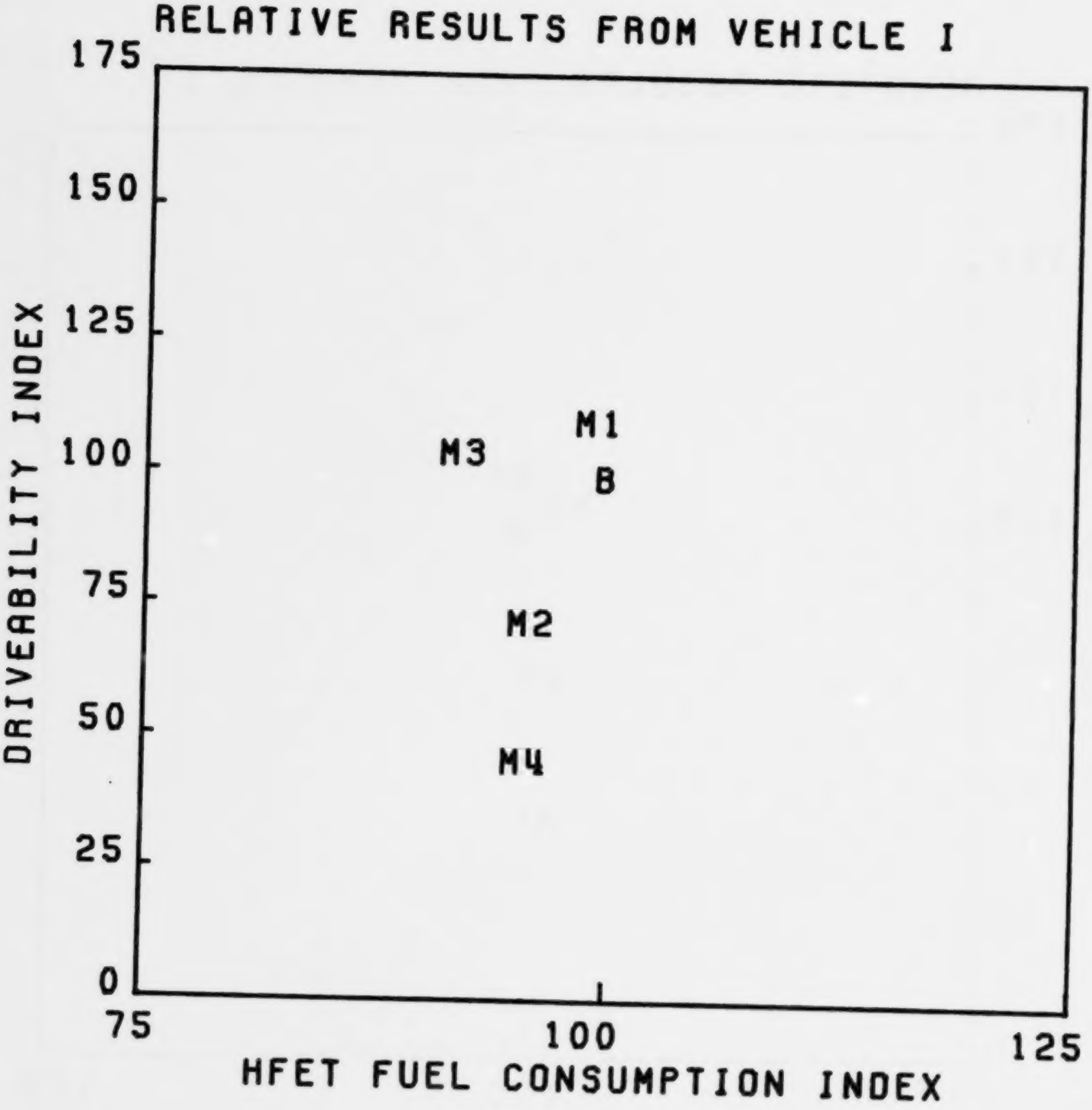

RELATIVE RESULTS FROM VEHICLE H
DRIVEABILITY INDEX
CO EMISSION INDEX
175
150
125
100
75
50
25
0
0
300
600
900
1200
1500
B
M1
M3
M2
M4

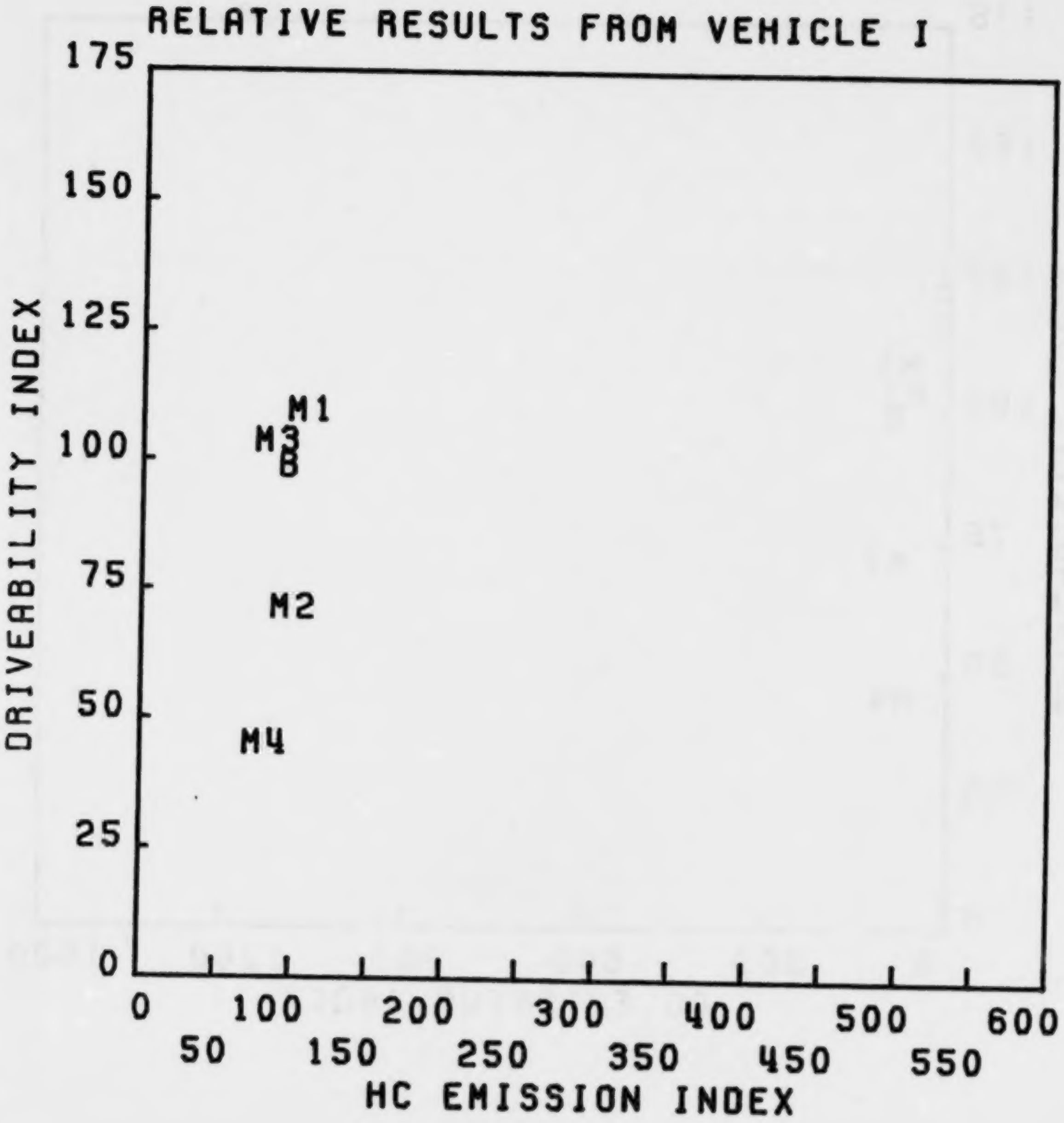

RELATIVE RESULTS FROM VEHICLE H
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX

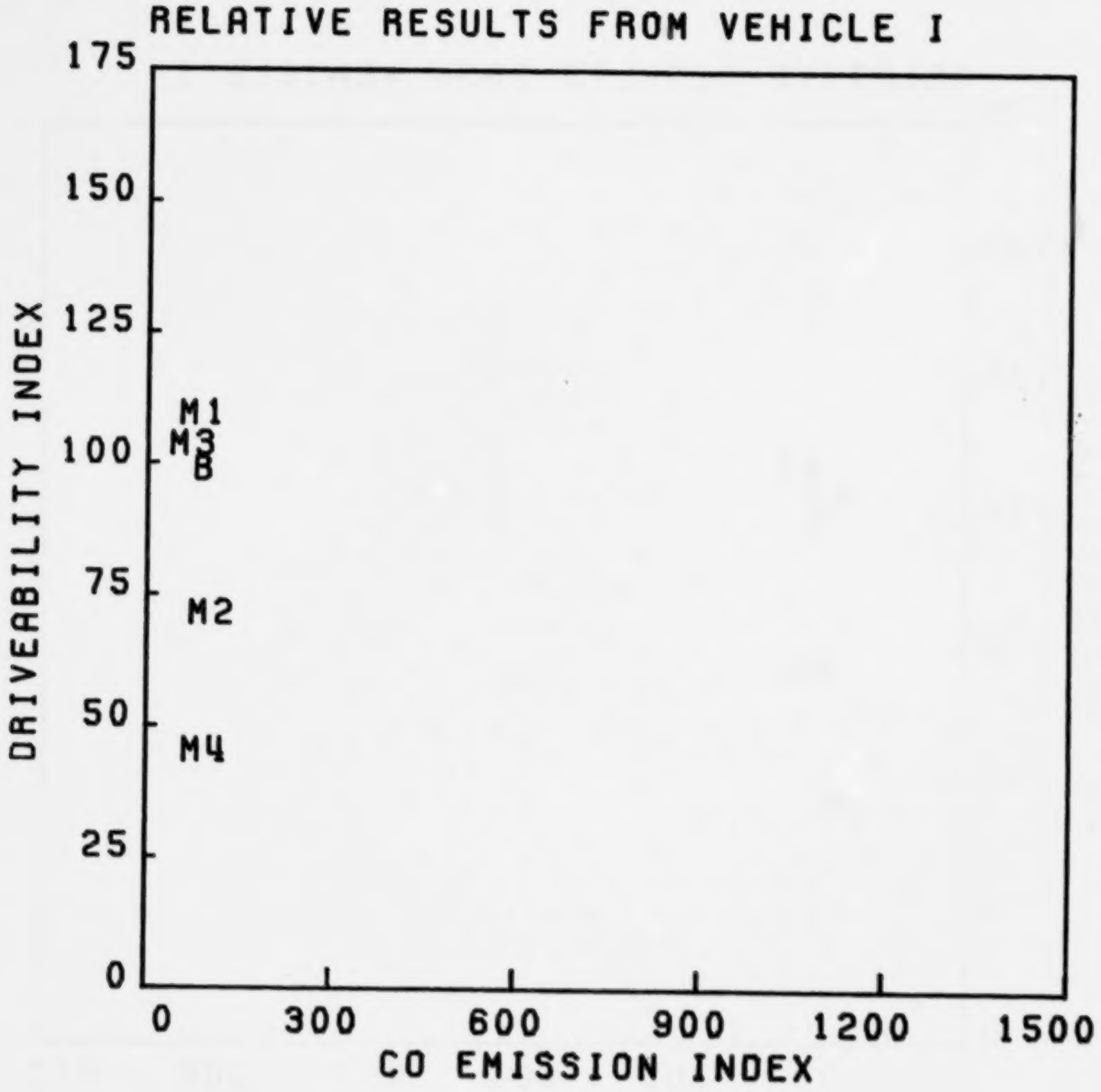


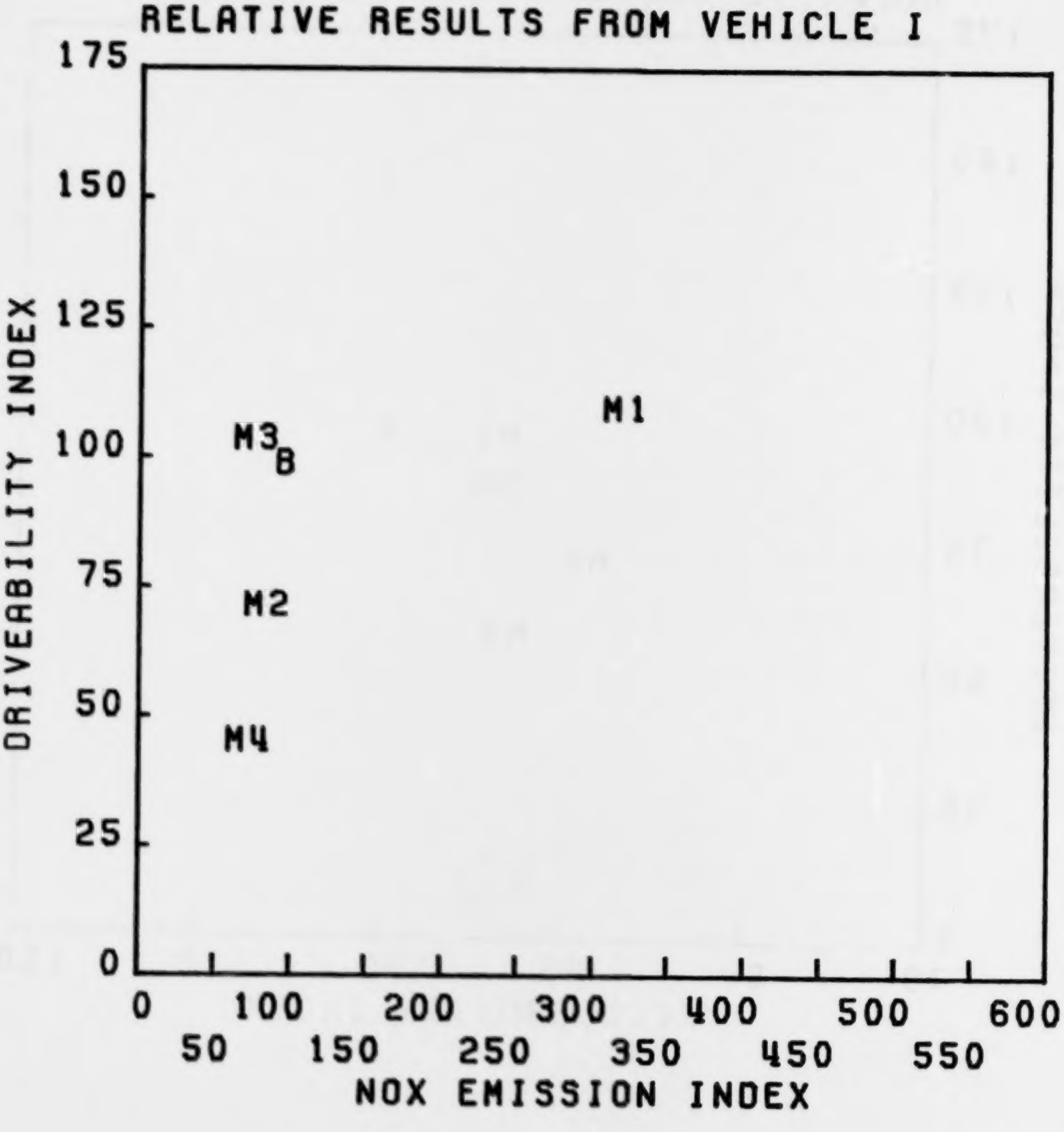
RELATIVE RESULTS FROM VEHICLE I


RELATIVE RESULTS FROM VEHICLE I
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
FTP FUEL CONSUMPTION INDEX
M1
M3
B
M2
M4

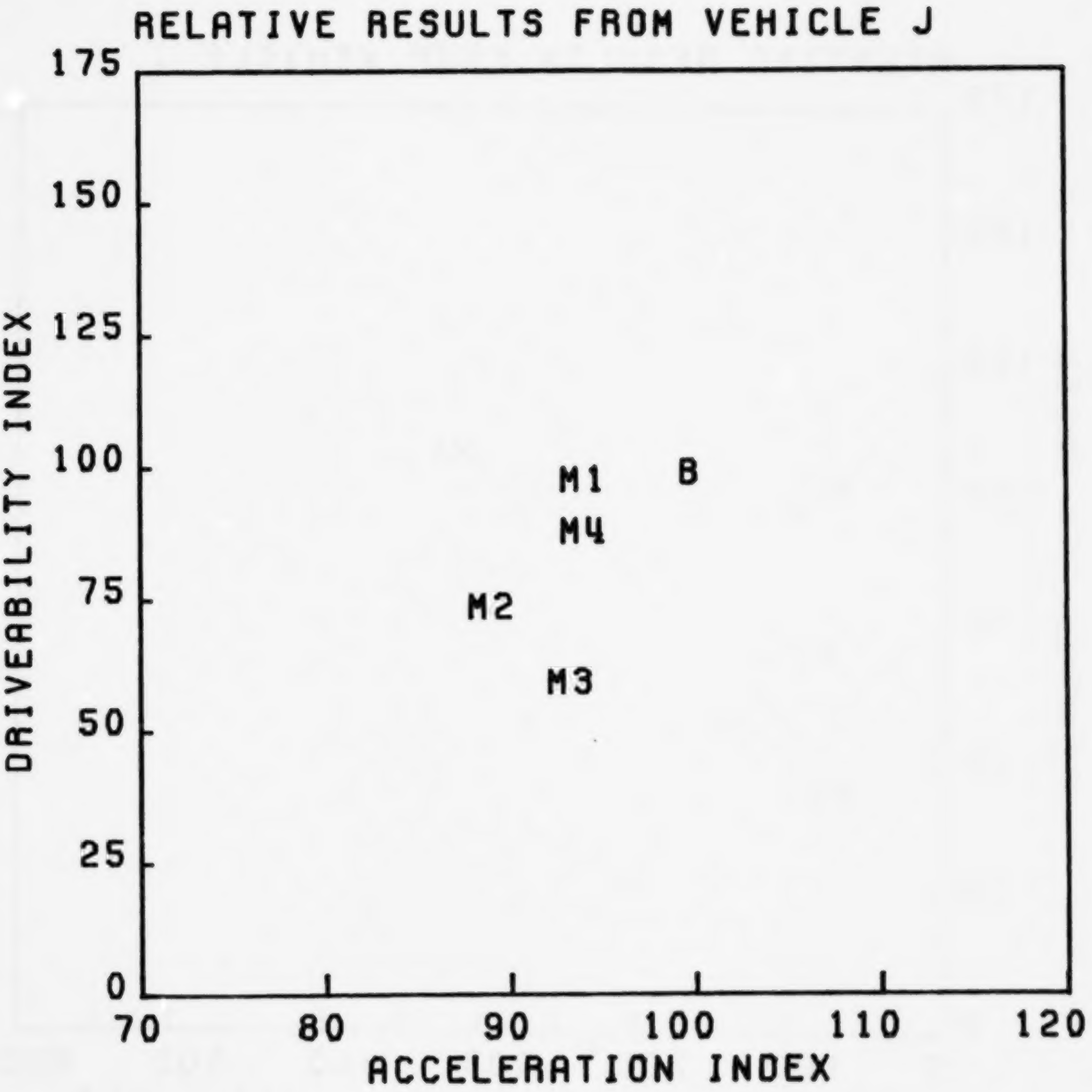

RELATIVE RESULTS FROM VEHICLE I
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
HFET FUEL CONSUMPTION INDEX
M1
M3
B
M2
M4


RELATIVE RESULTS FROM VEHICLE I
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M1
M3
B
M2
M4
0
100
200
300
400
500
600
50
150
250
350
450
550
HC EMISSION INDEX

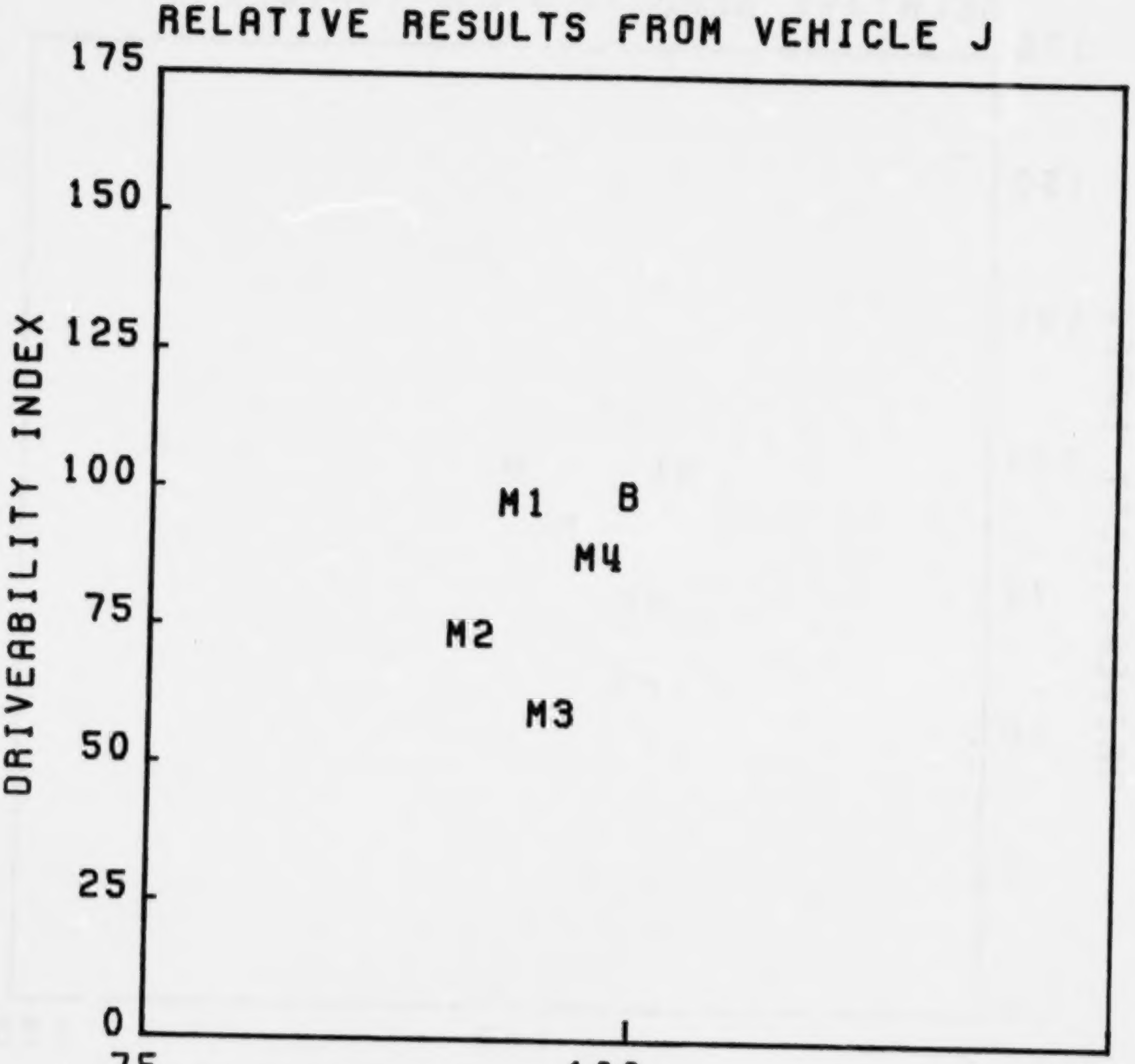
RELATIVE RESULTS FROM VEHICLE I
DRIVEABILITY INDEX
CO EMISSION INDEX
175
150
125
100
75
50
25
0
0
300
600
900
1200
1500
M1
M3
B
M2
M4

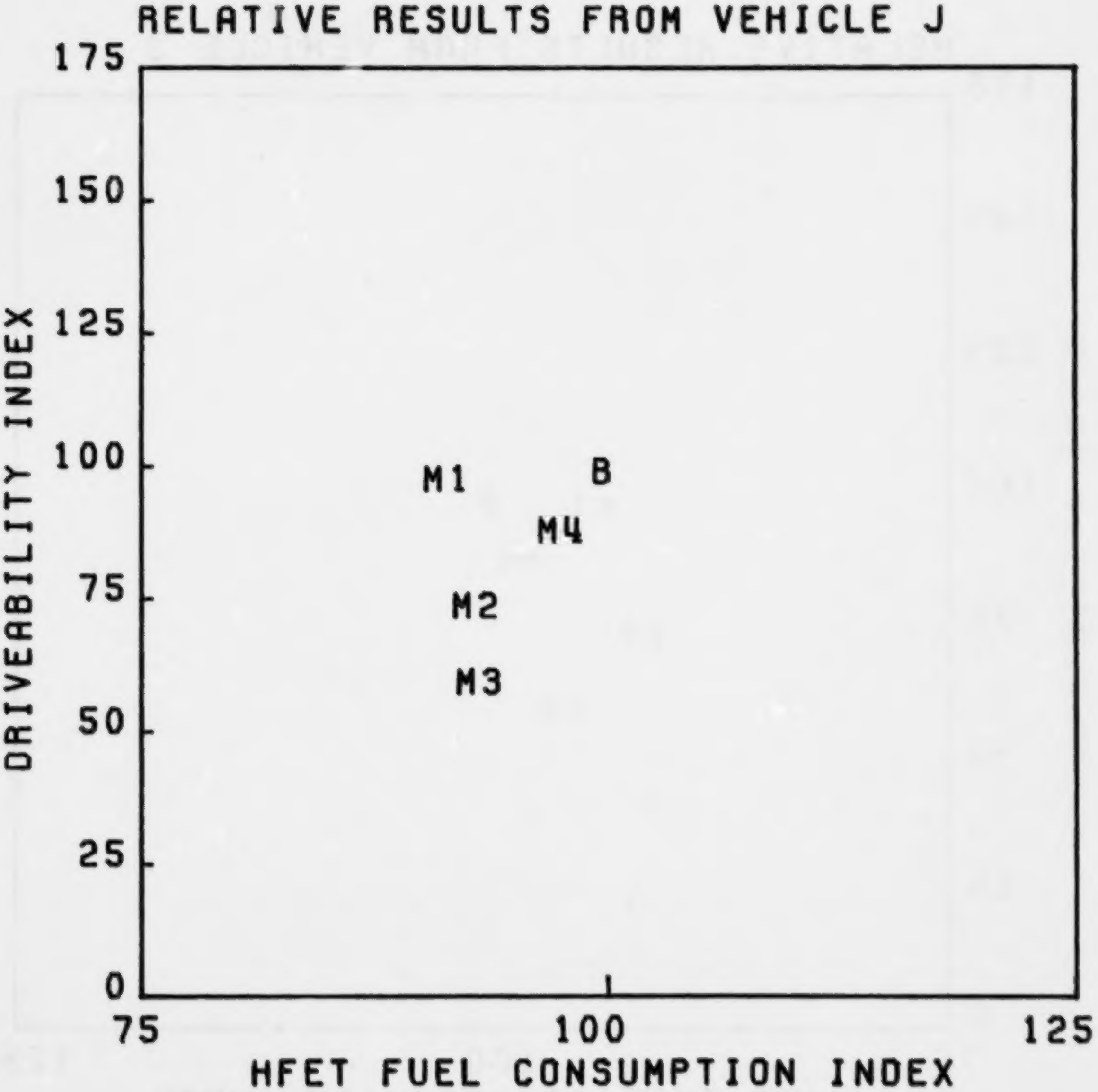


RELATIVE RESULTS FROM VEHICLE I
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M1
M3
B
M2
M4
0
100
200
300
400
500
600
50
150
250
350
450
550
NOX EMISSION INDEX



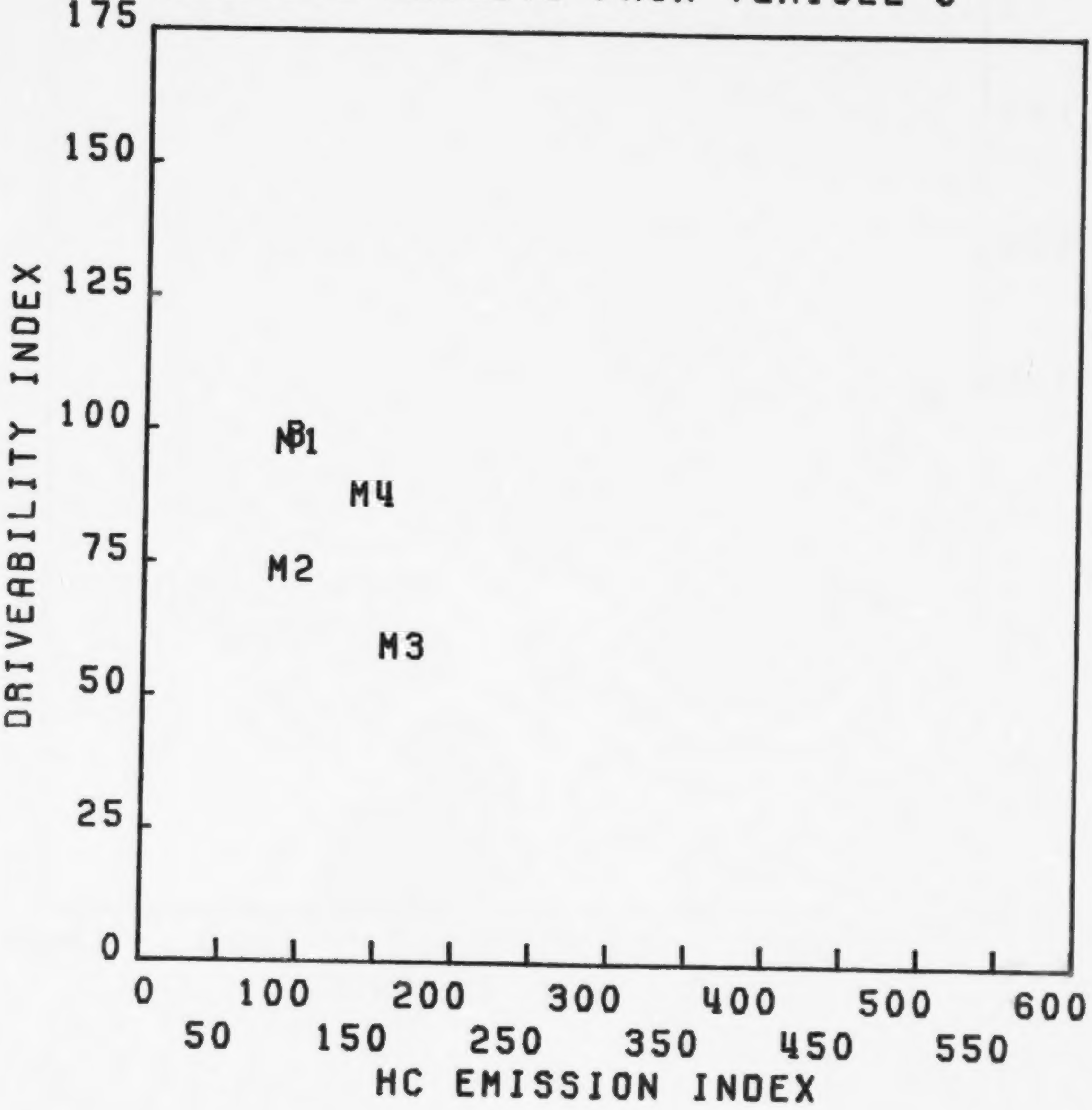
RELATIVE RESULTS FROM VEHICLE J


RELATIVE RESULTS FROM VEHICLE J
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
FTP FUEL CONSUMPTION INDEX
75
100
125
M1
B
M4
M2
M3

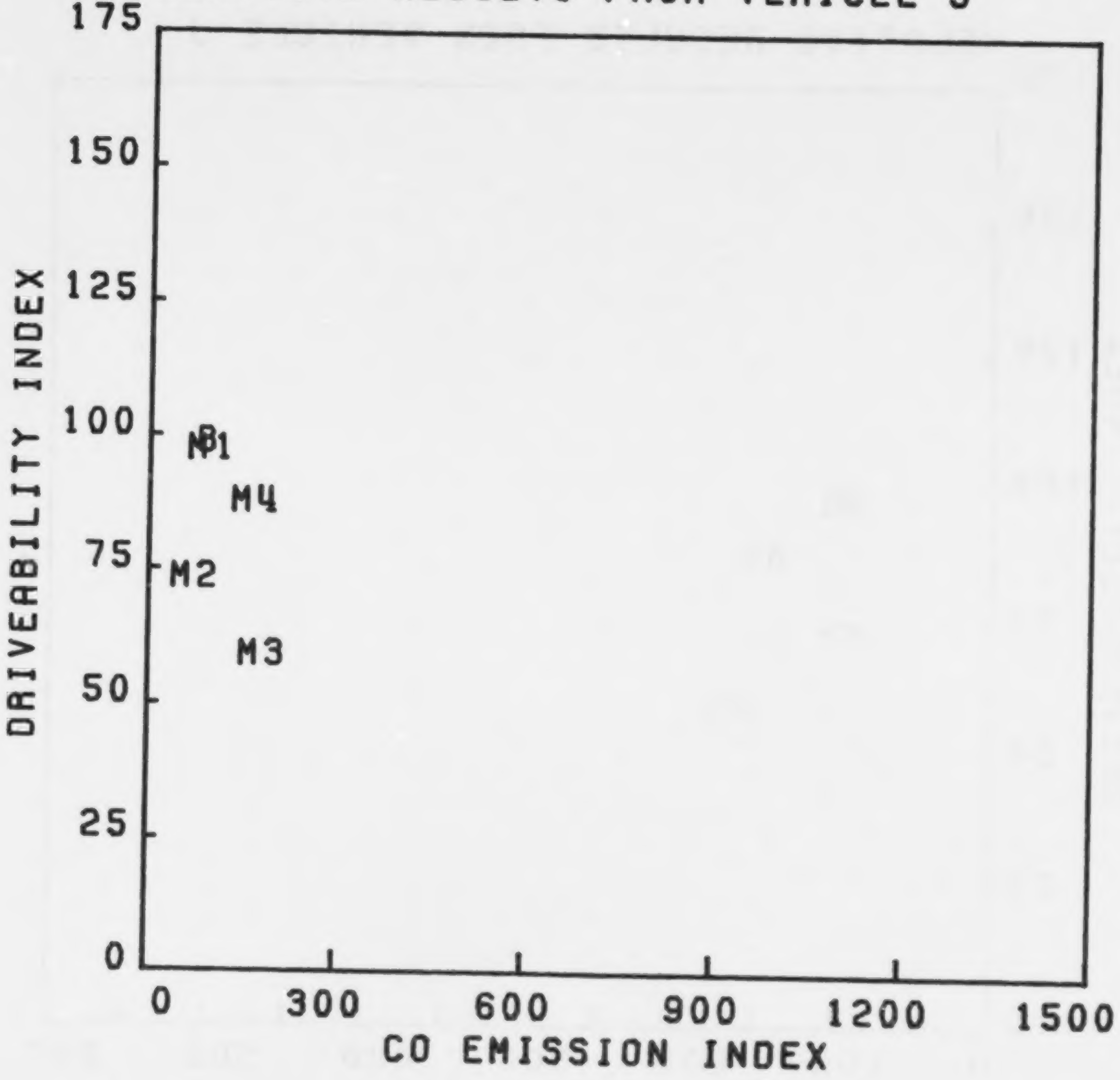


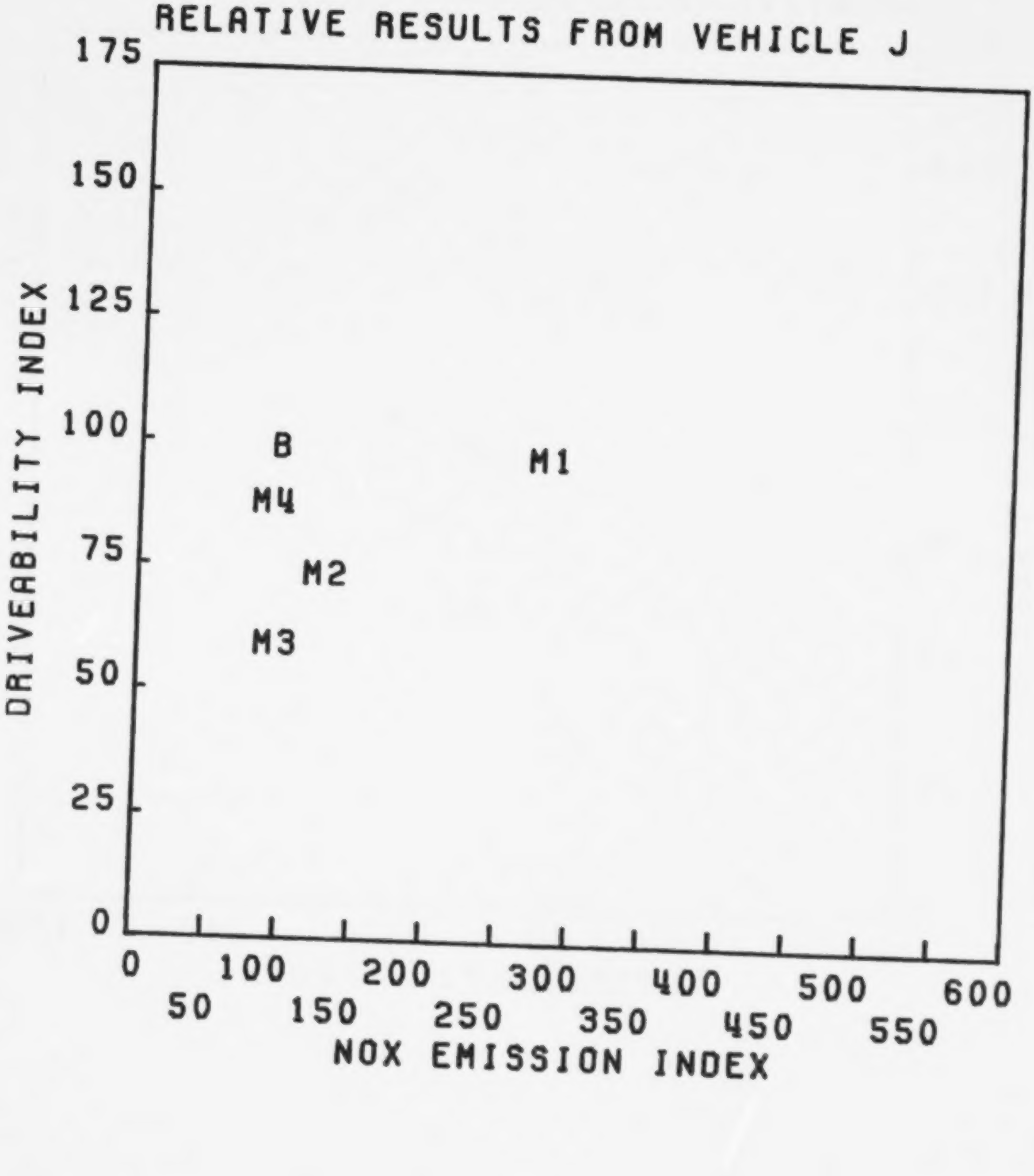
RELATIVE RESULTS FROM VEHICLE J
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M1
B
M4
M2
M3
75
100
125
HFET FUEL CONSUMPTION INDEX

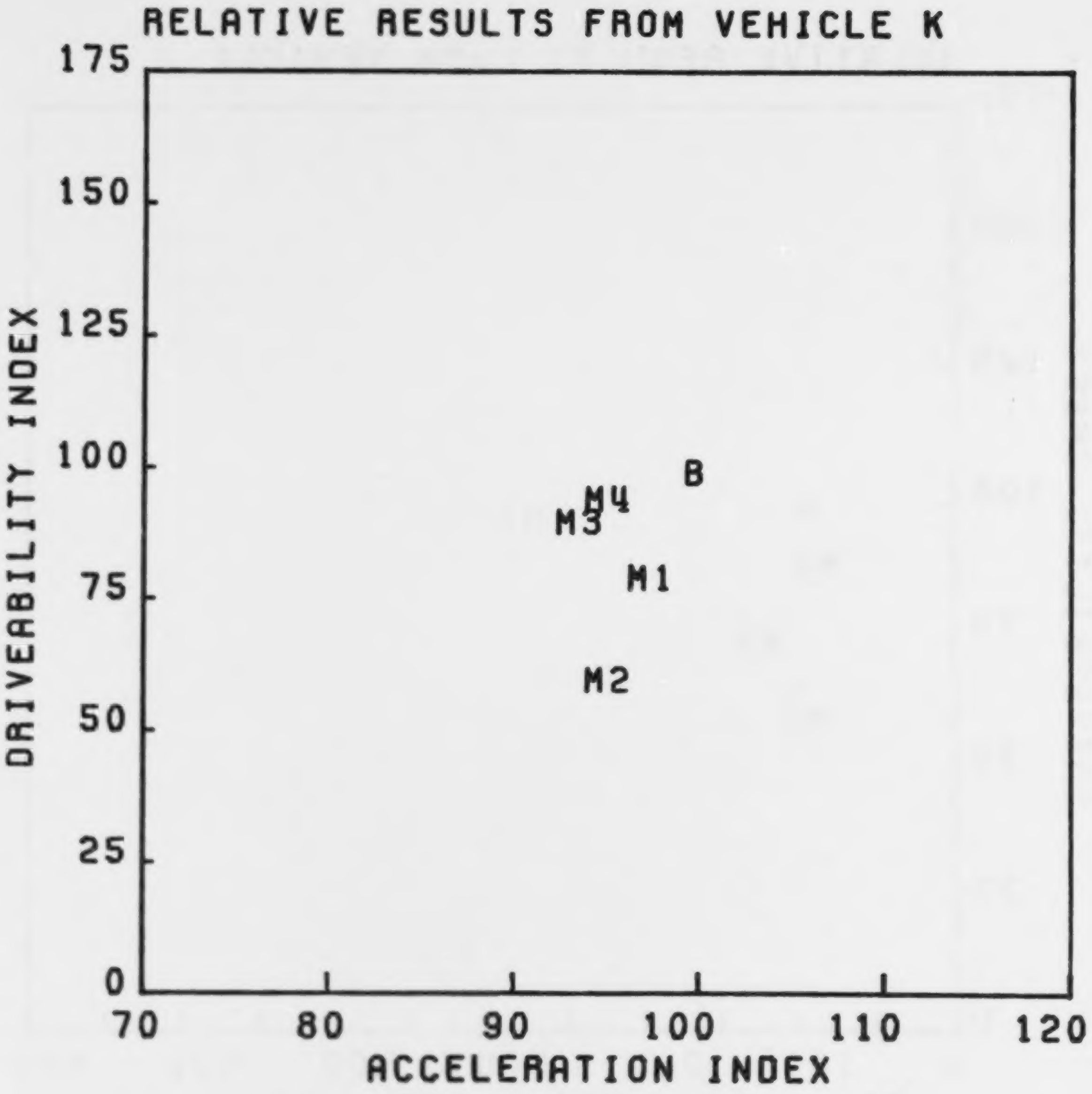
RELATIVE RESULTS FROM VEHICLE J

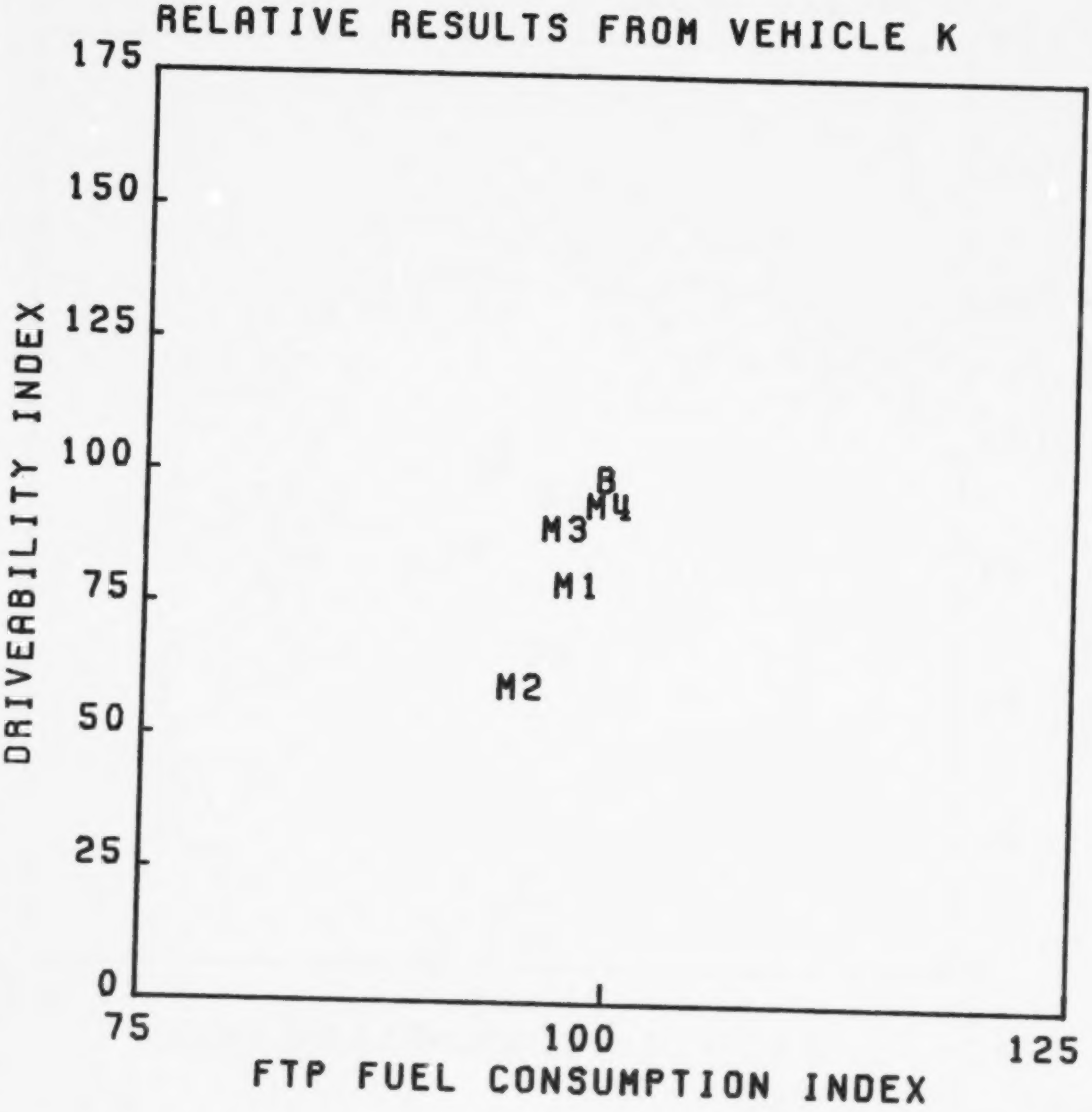


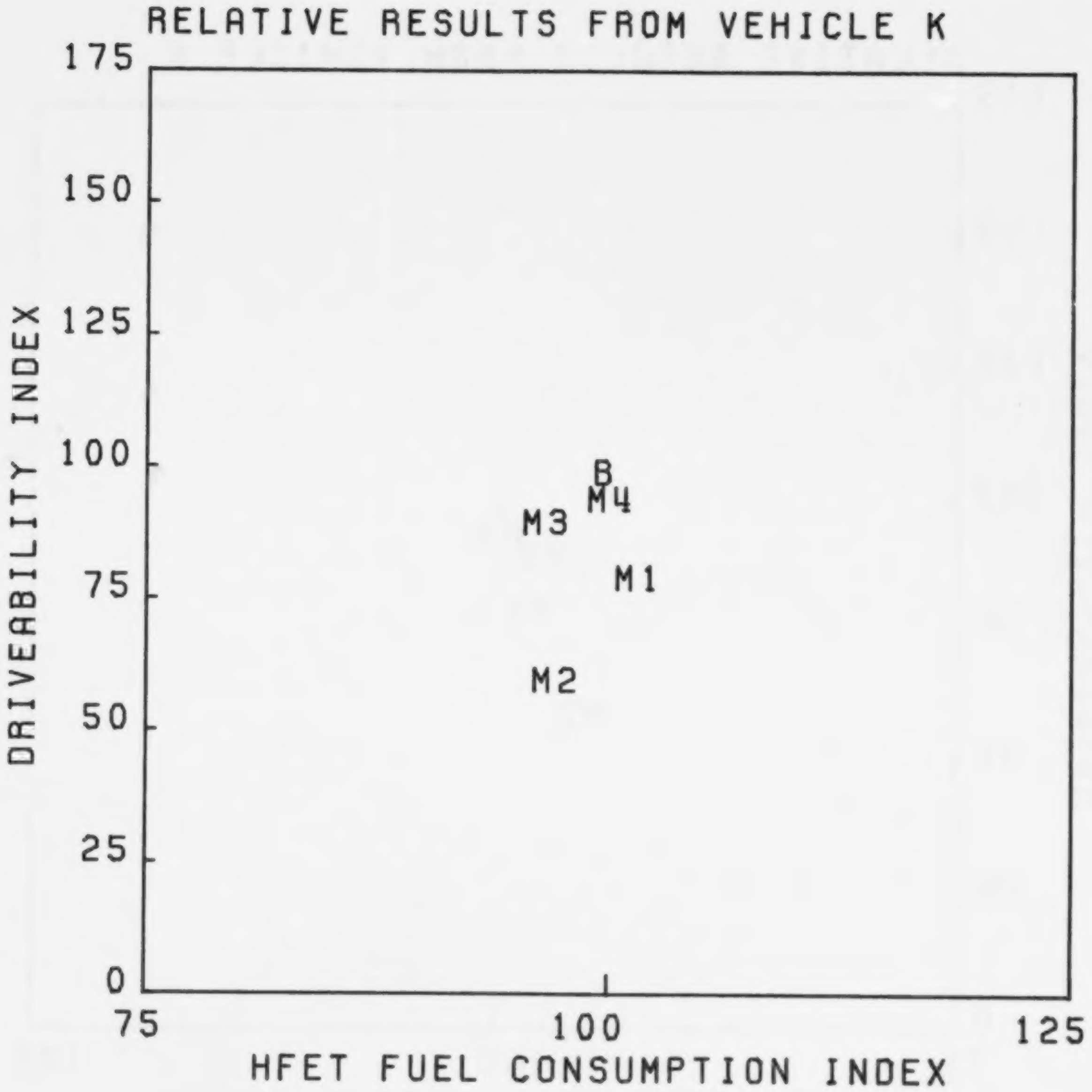
RELATIVE RESULTS FROM VEHICLE J

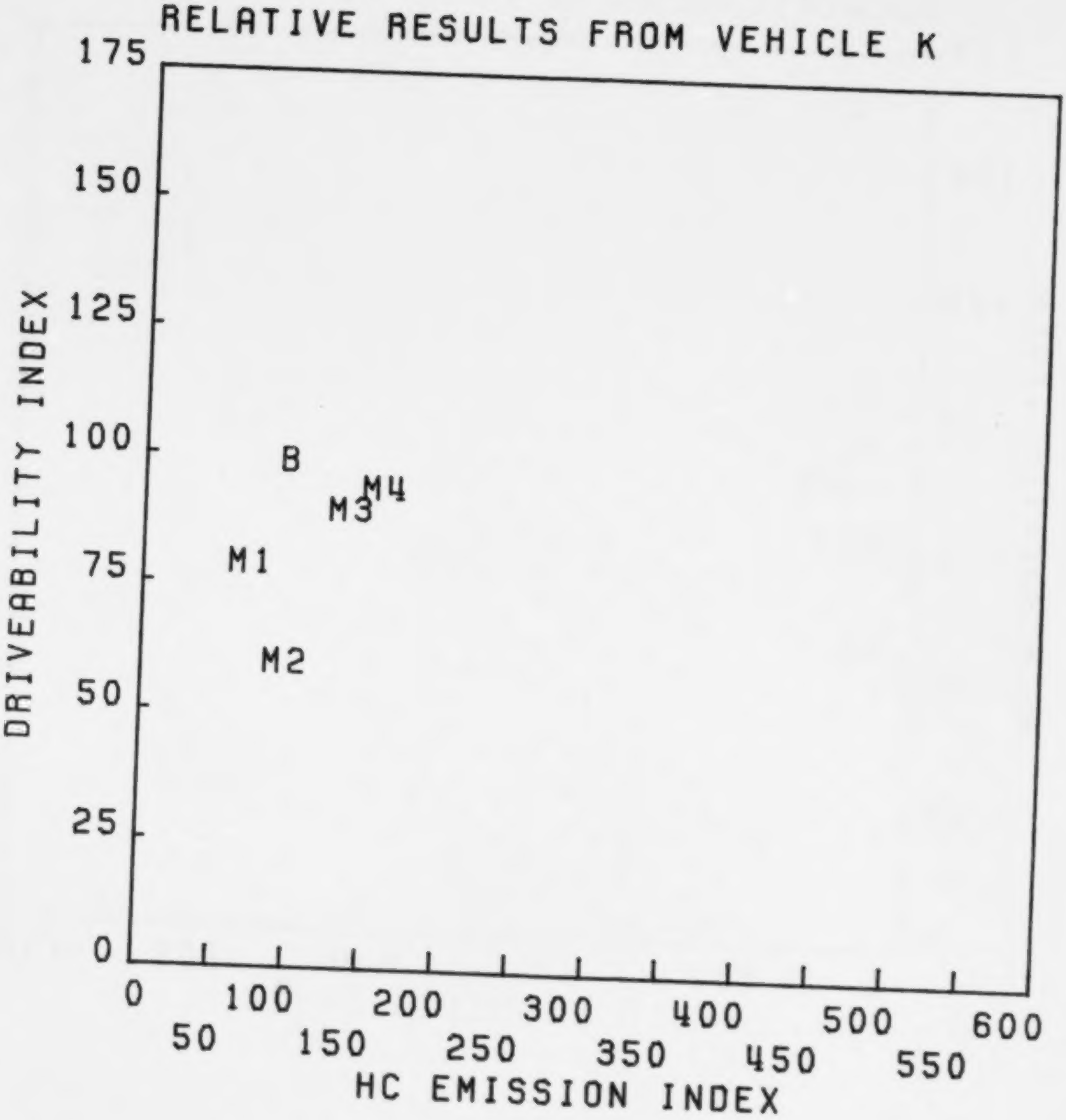


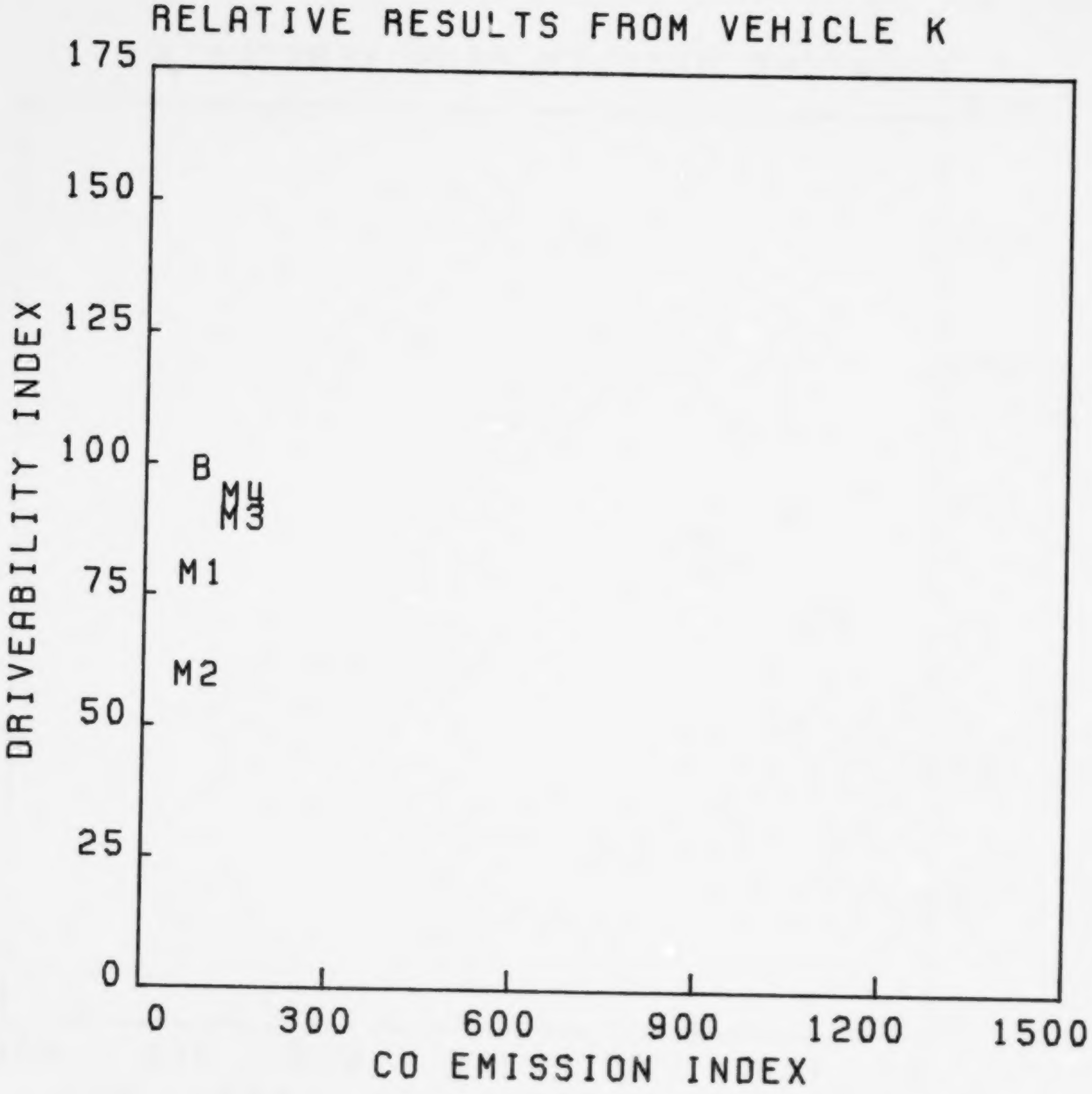

RELATIVE RESULTS FROM VEHICLE J
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
B
M1
M4
M2
M3
0
100
200
300
400
500
600
50
150
250
350
450
550
NOX EMISSION INDEX


RELATIVE RESULTS FROM VEHICLE K
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
70
80
90
100
110
120
ACCELERATION INDEX
B
M4
M3
M1
M2

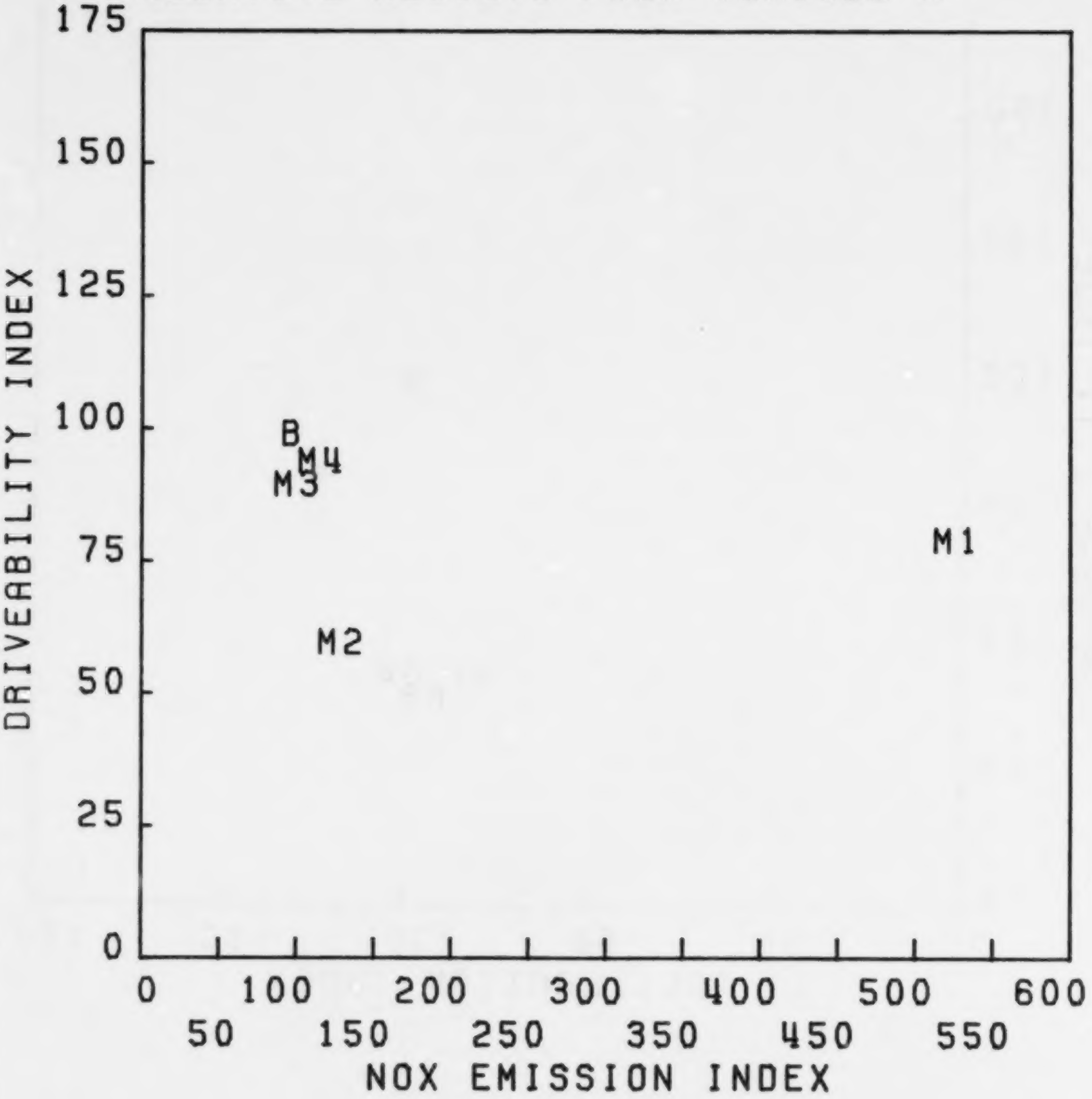

RELATIVE RESULTS FROM VEHICLE K
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
75
100
125
FTP FUEL CONSUMPTION INDEX
B
M4
M3
M1
M2

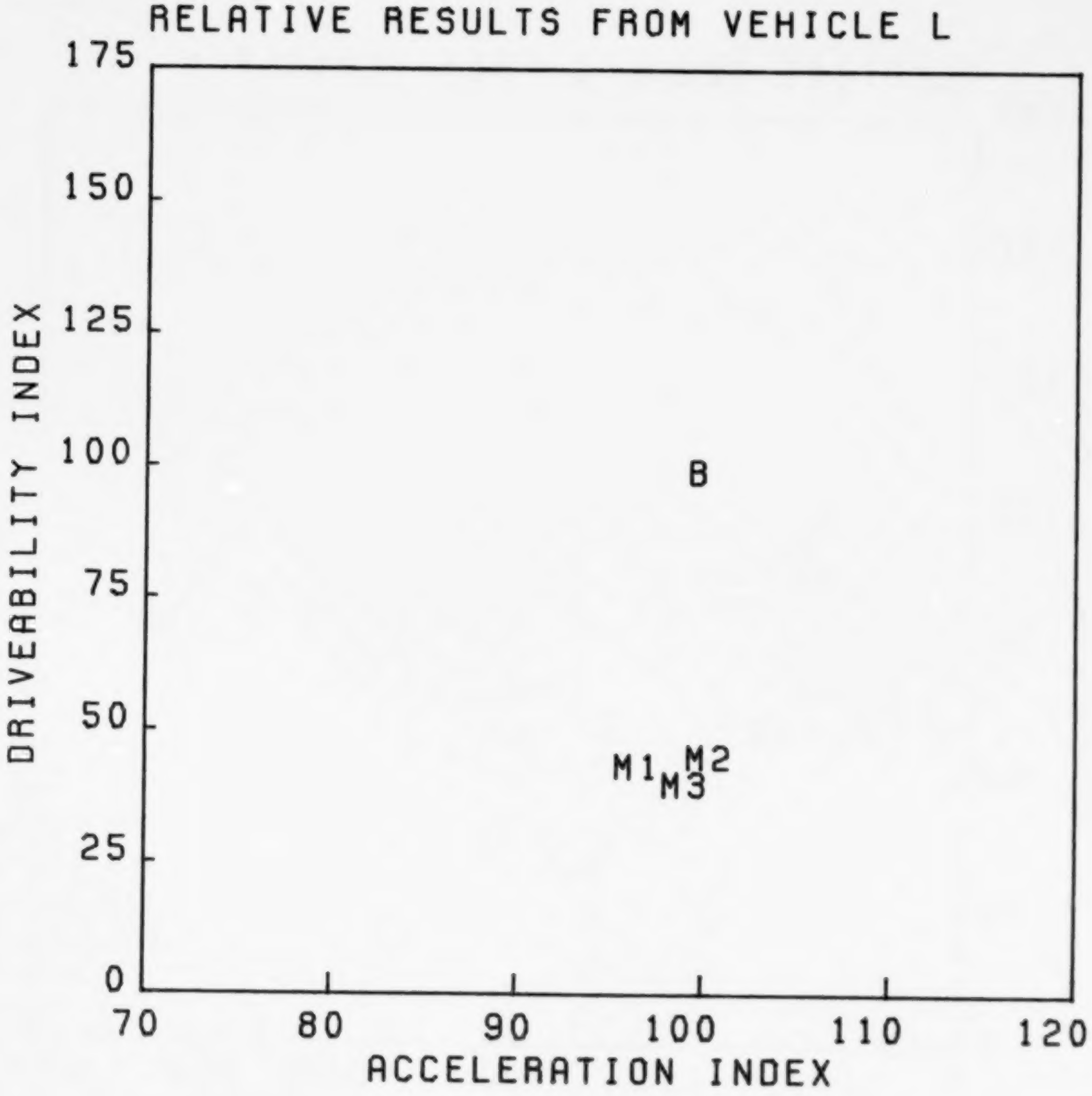

RELATIVE RESULTS FROM VEHICLE K
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
75
100
125
HFET FUEL CONSUMPTION INDEX
B
M4
M3
M1
M2

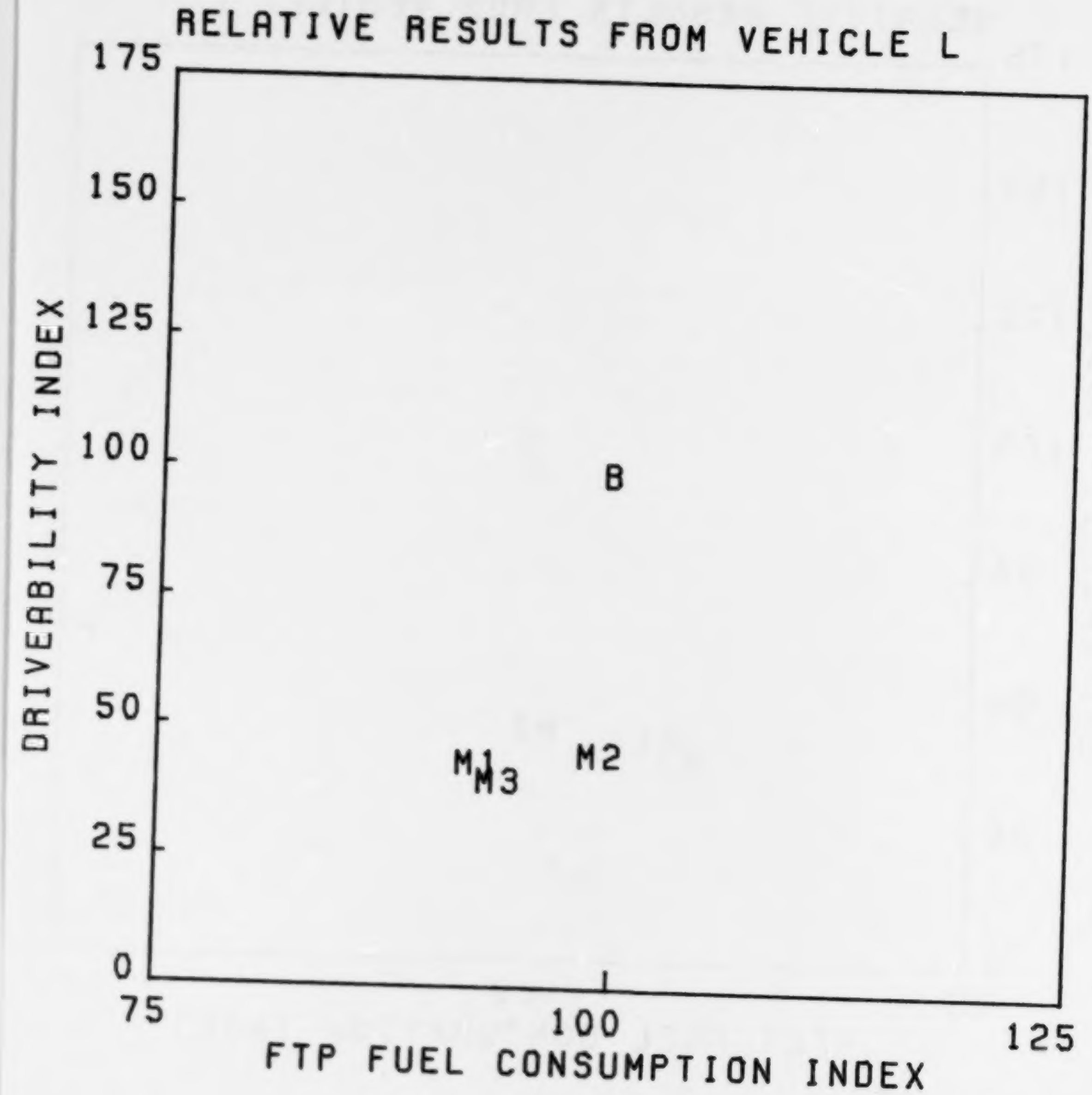

RELATIVE RESULTS FROM VEHICLE K
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M4
M3
M1
M2
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX

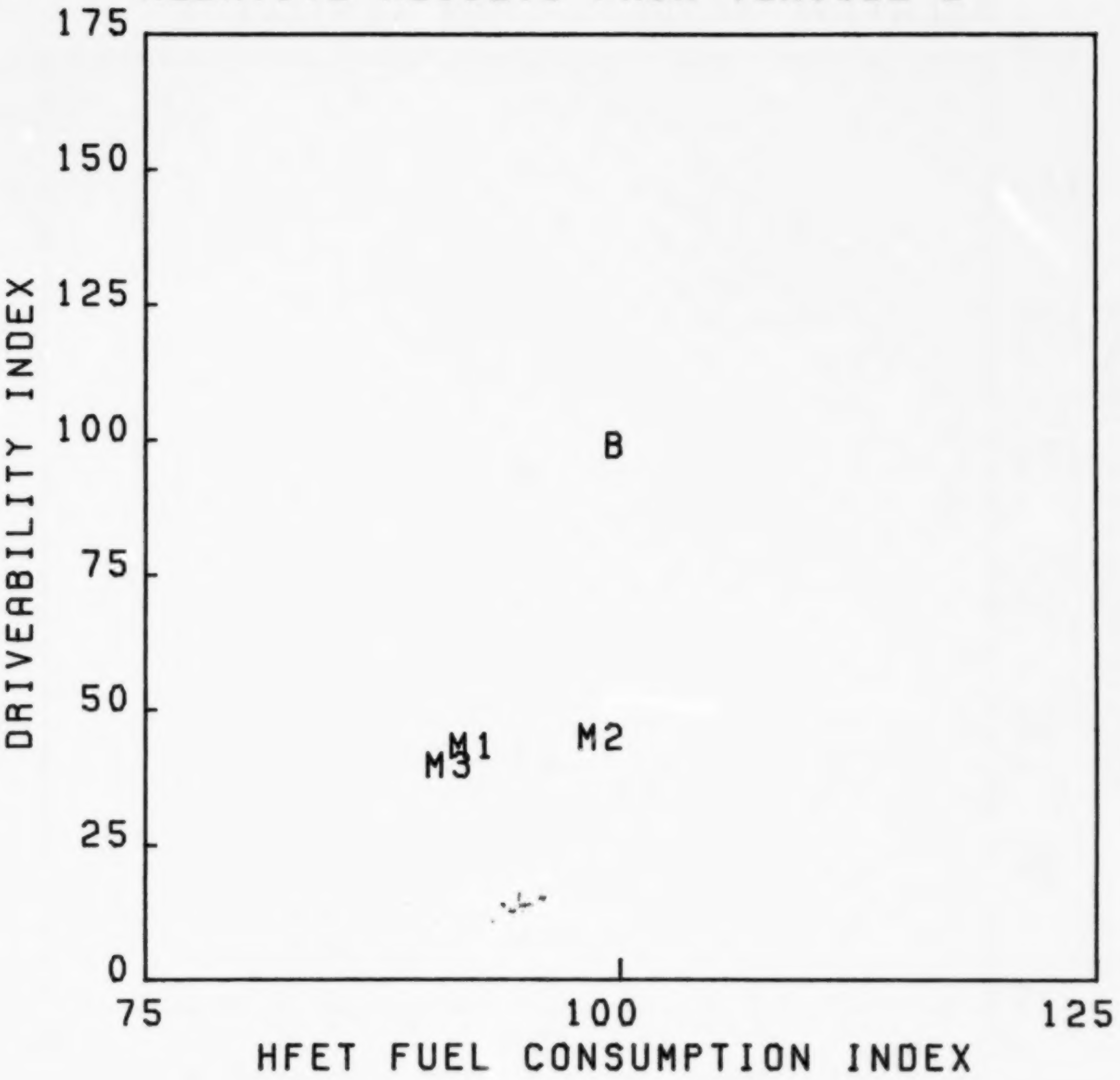

RELATIVE RESULTS FROM VEHICLE K
DRIVEABILITY INDEX
CO EMISSION INDEX
175
150
125
100
75
50
25
0
0
300
600
900
1200
1500
B
M4
M3
M1
M2

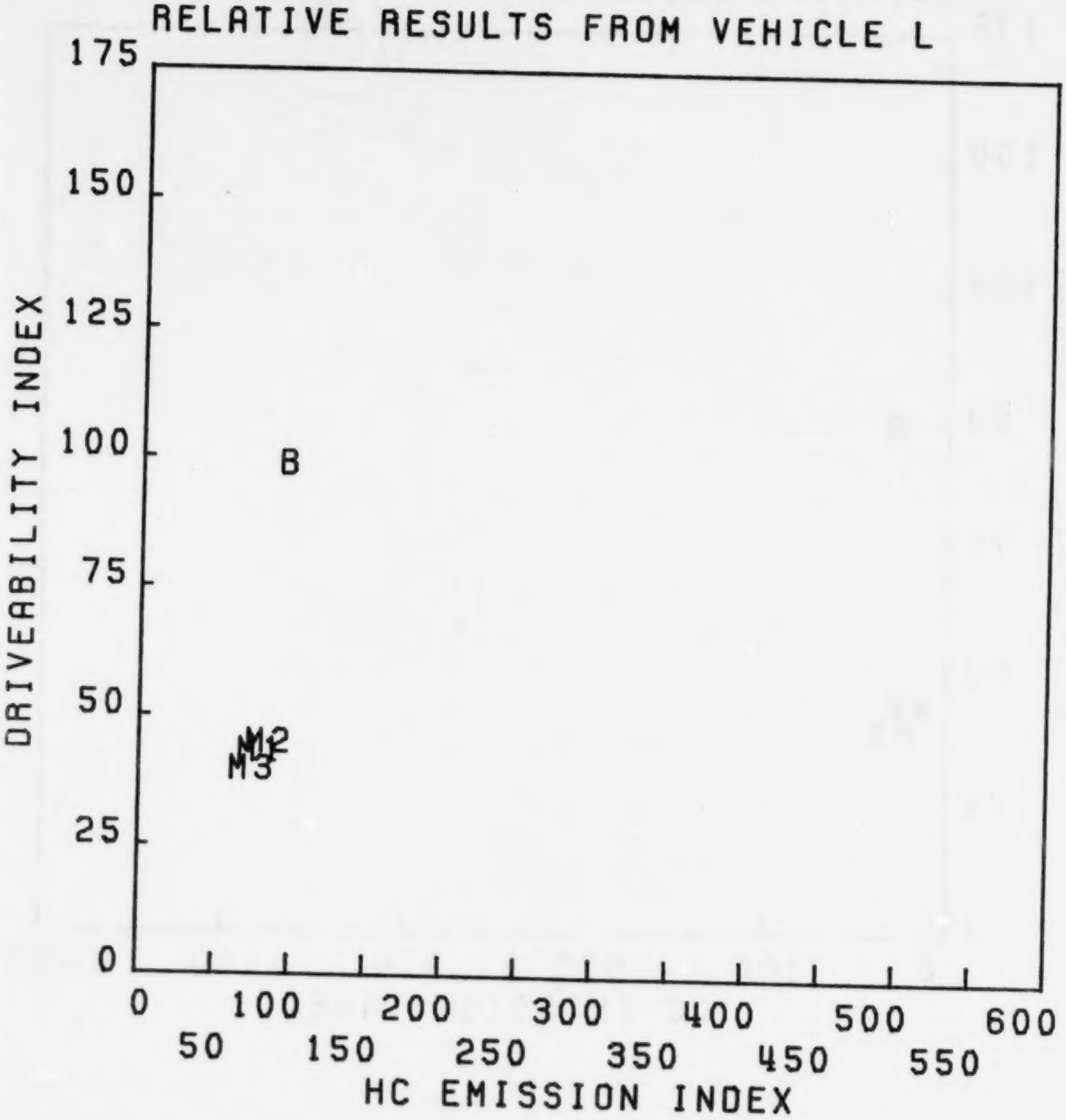
RELATIVE RESULTS FROM VEHICLE K

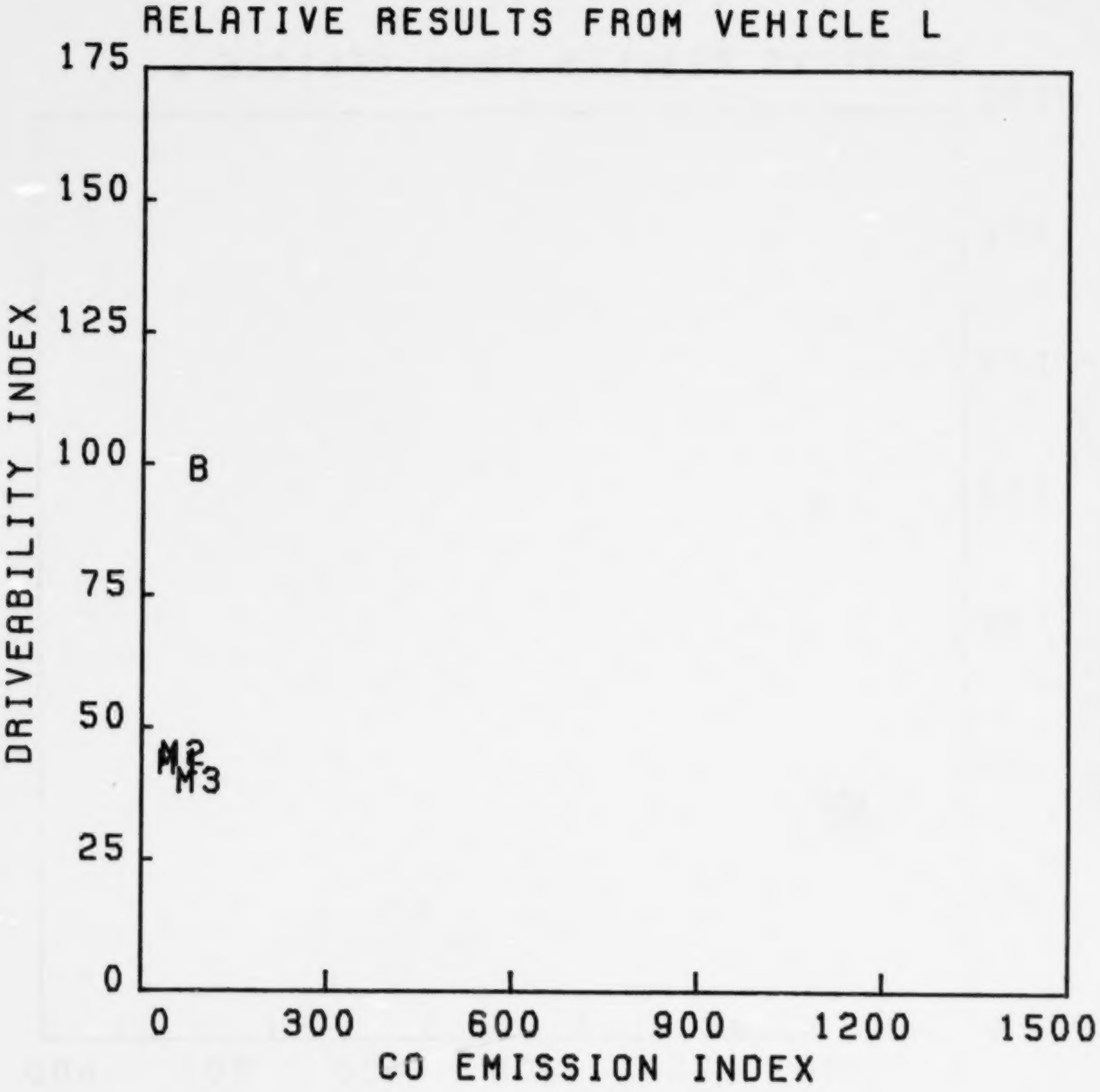


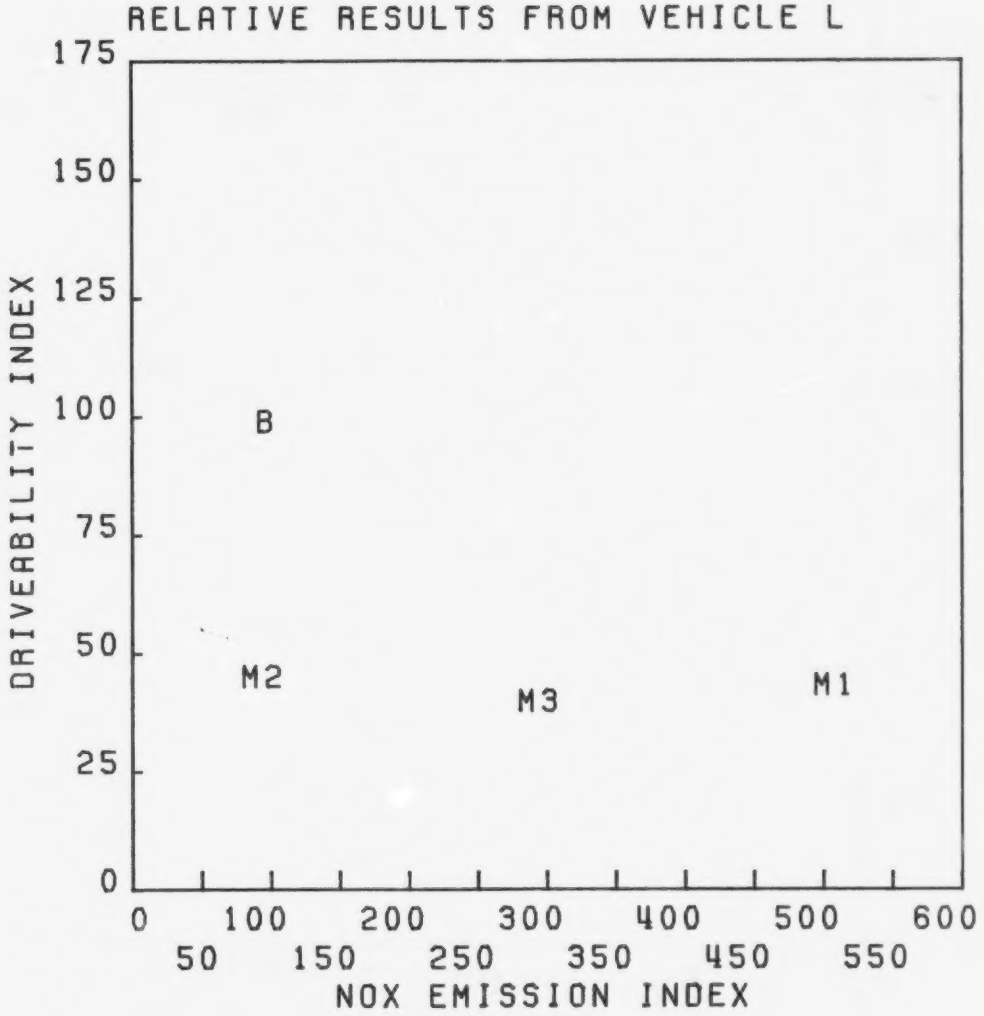

RELATIVE RESULTS FROM VEHICLE L

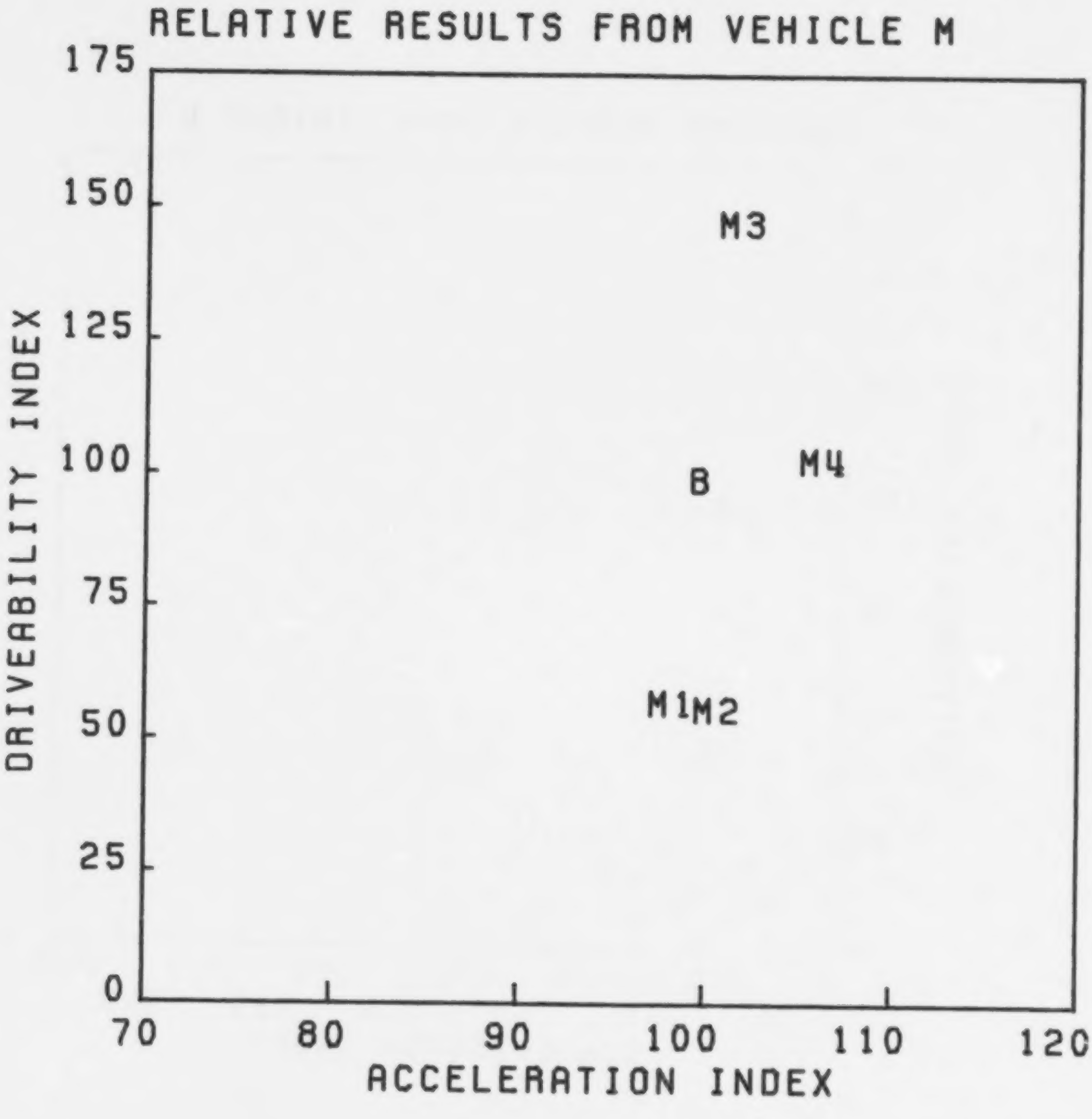

RELATIVE RESULTS FROM VEHICLE L
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
FTP FUEL CONSUMPTION INDEX
75
100
125
B
M1
M3
M2

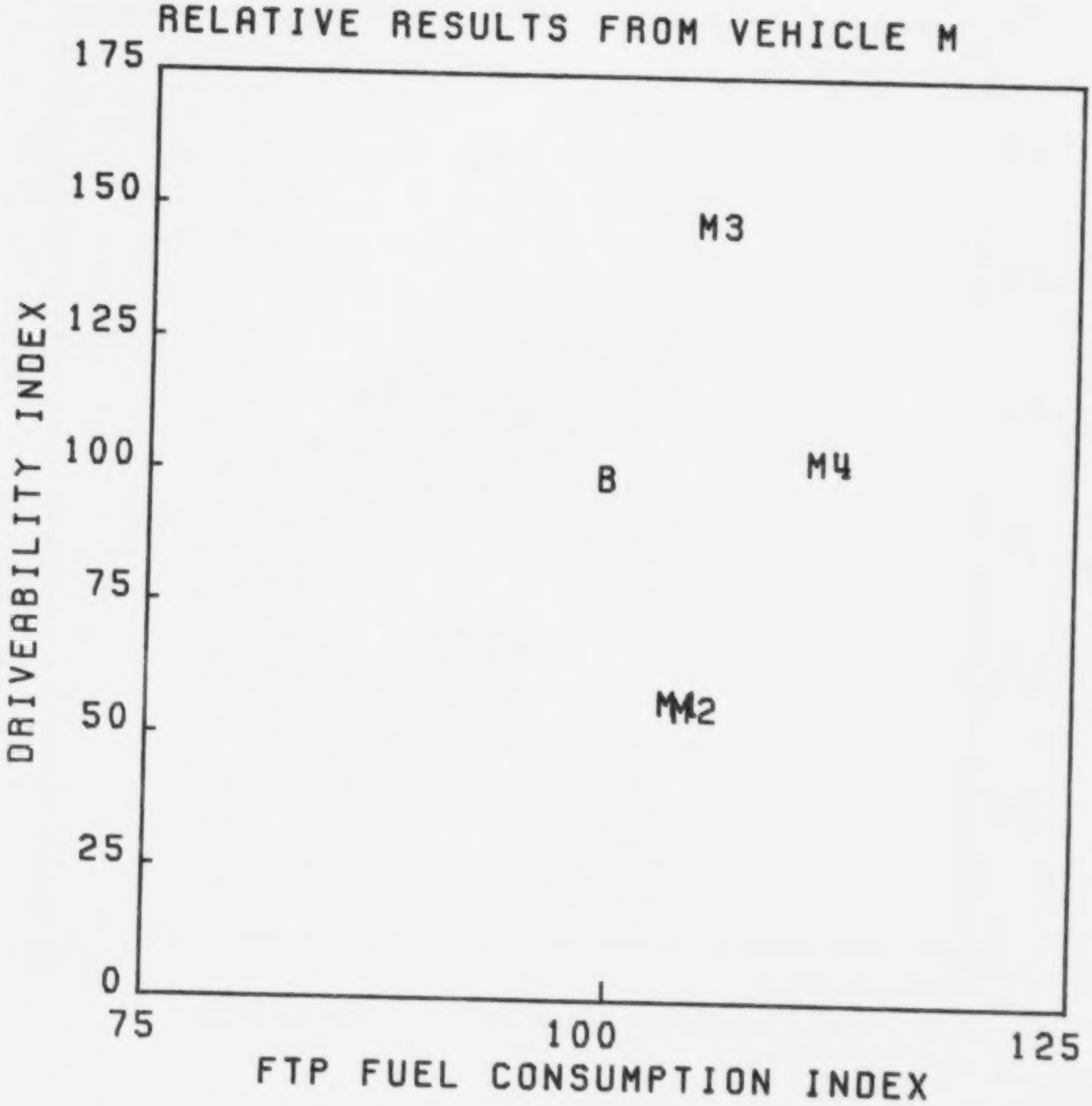

RELATIVE RESULTS FROM VEHICLE L
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
HFET FUEL CONSUMPTION INDEX
B
M1
M2
M3


RELATIVE RESULTS FROM VEHICLE L
DRIVEABILITY INDEX
0
25
50
75
100
125
150
175
HC EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
B
M2
M1
M3

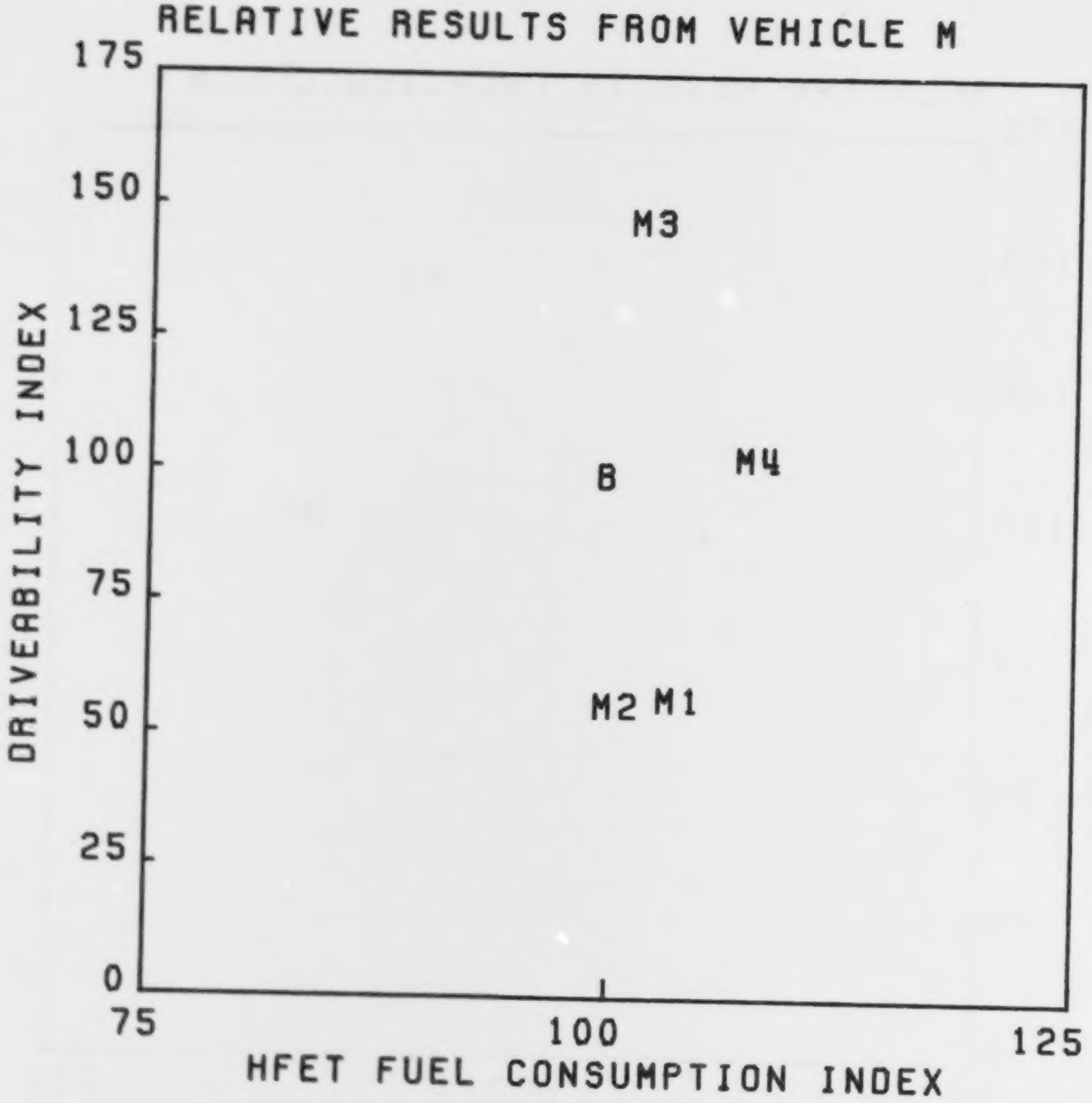

RELATIVE RESULTS FROM VEHICLE L
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M2
M1
M3
0
300
600
900
1200
1500
CO EMISSION INDEX

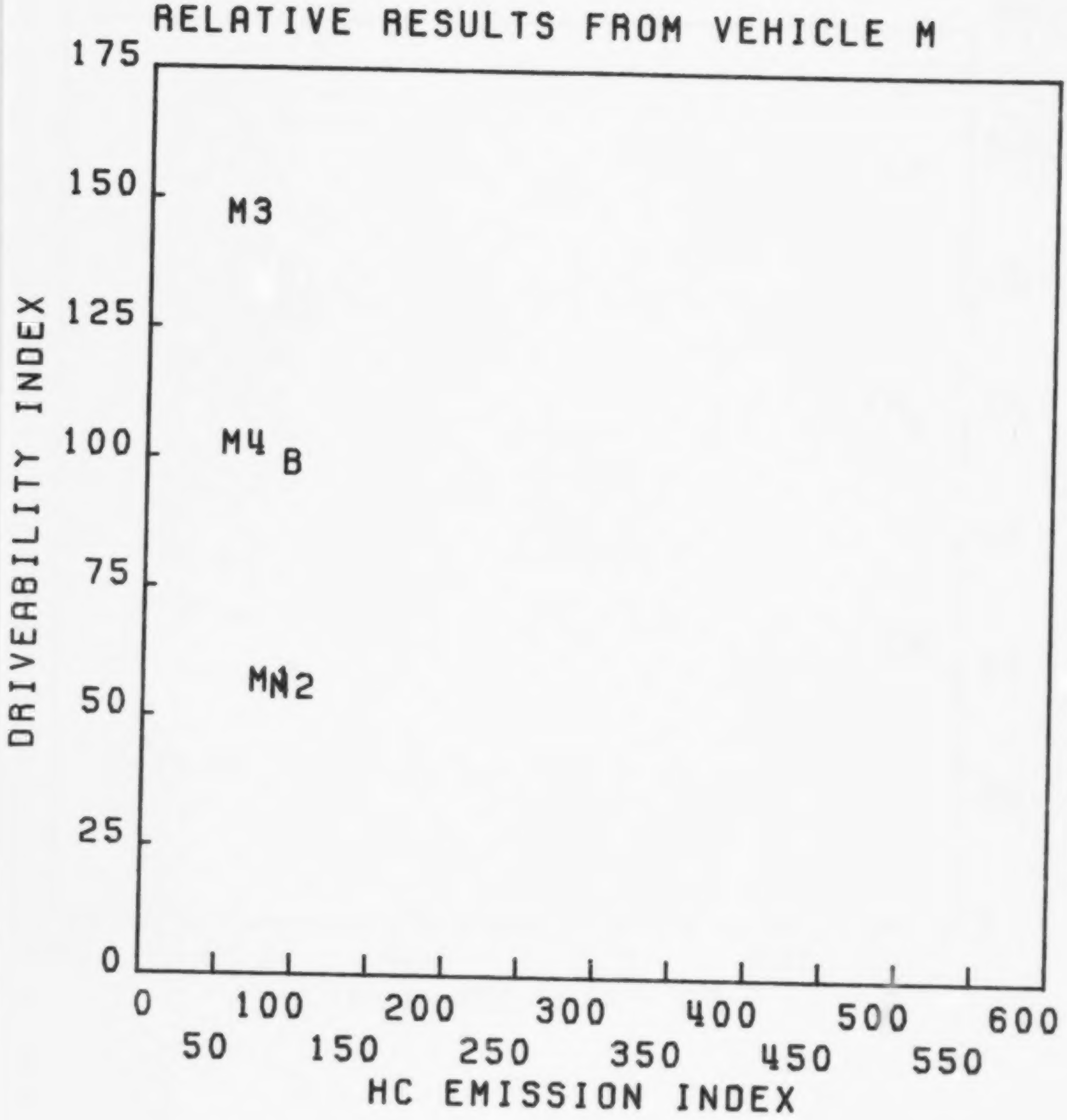

RELATIVE RESULTS FROM VEHICLE L
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M2
M3
M1
0
100
200
300
400
500
600
50
150
250
350
450
550
NOX EMISSION INDEX

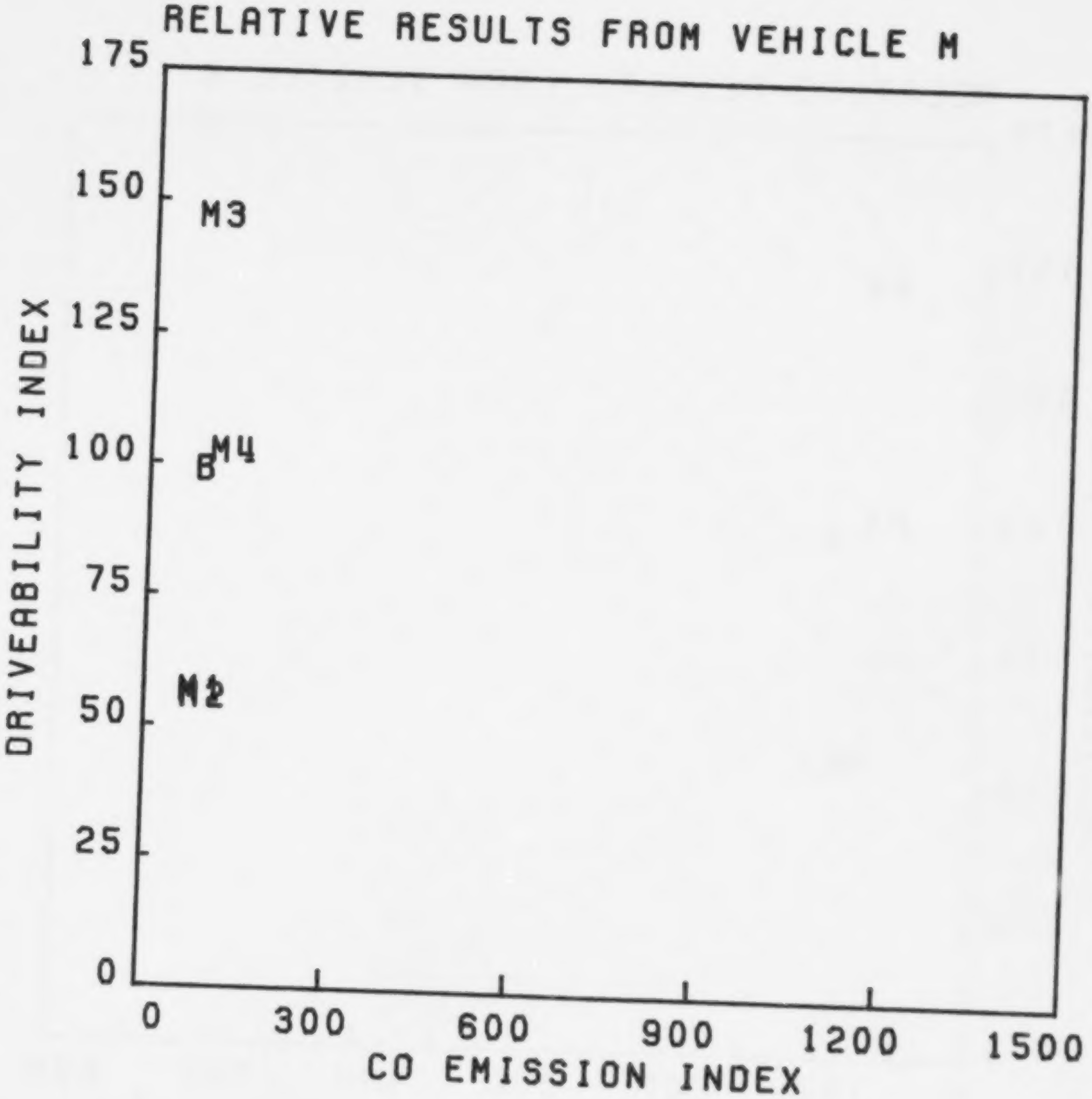

RELATIVE RESULTS FROM VEHICLE M
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
70
80
90
100
110
120
ACCELERATION INDEX
M3
B
M4
M1
M2

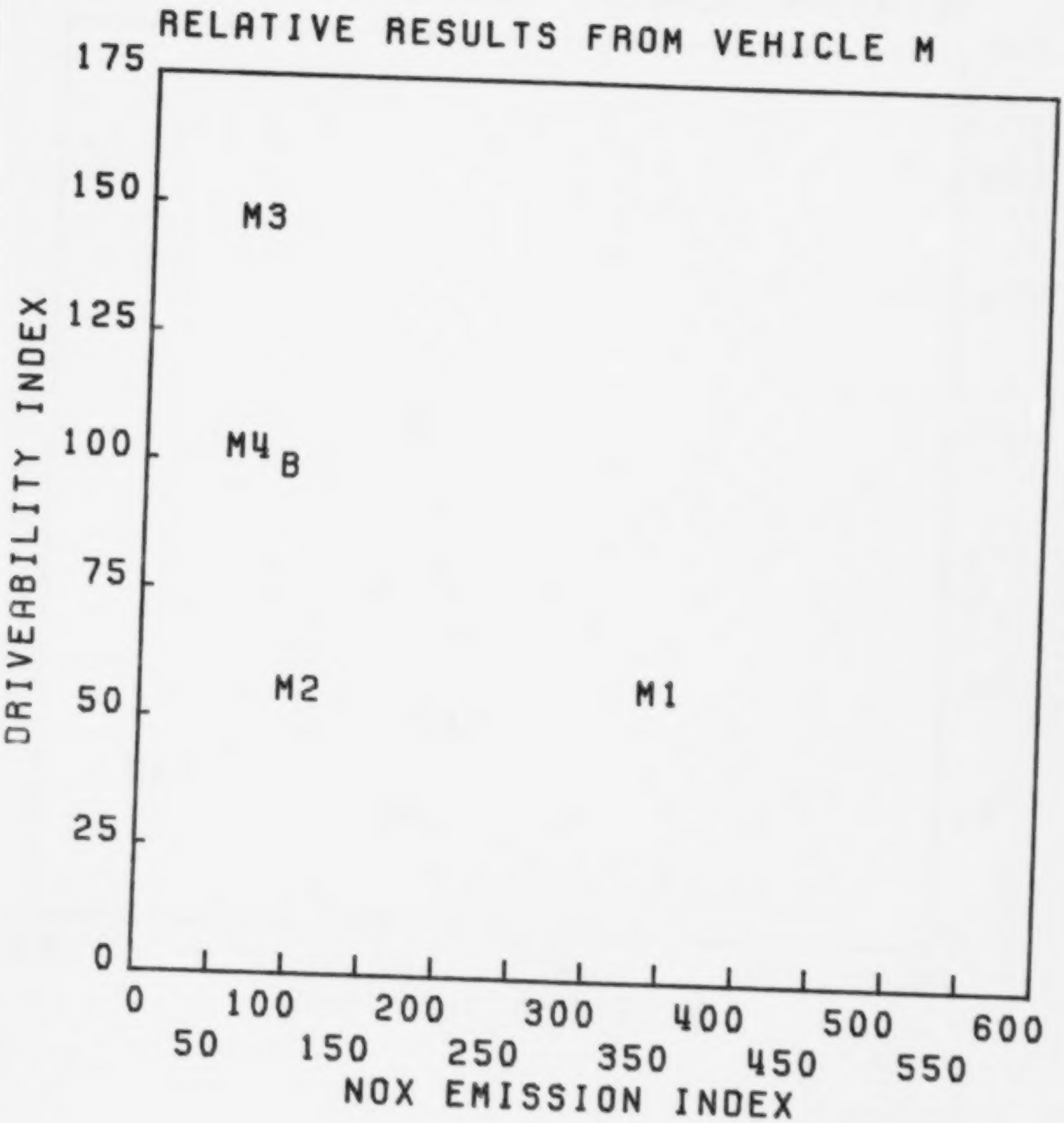


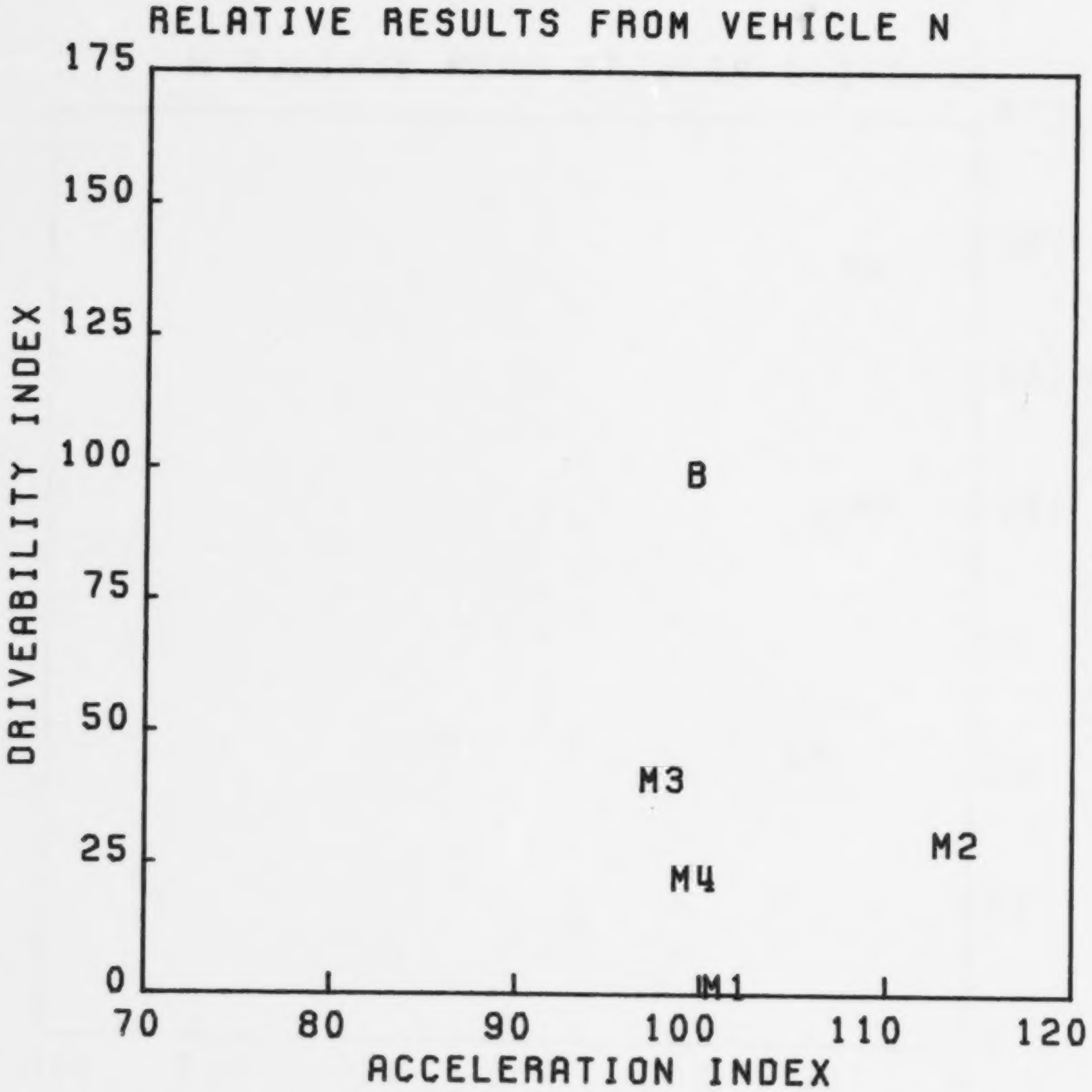
RELATIVE RESULTS FROM VEHICLE M

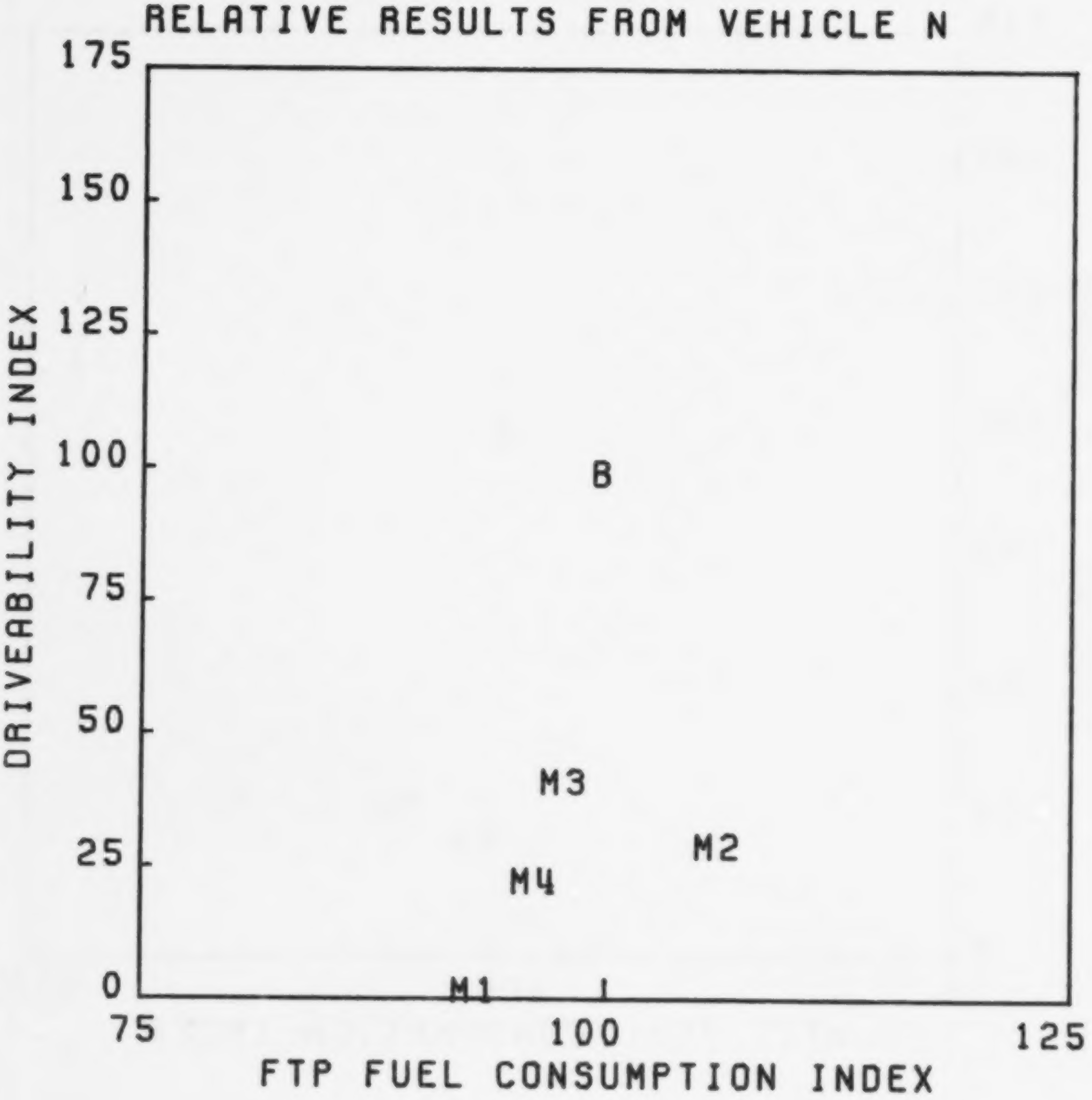

RELATIVE RESULTS FROM VEHICLE M
DRIVEABILITY INDEX
HFET FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
M3
B
M4
M2
M1

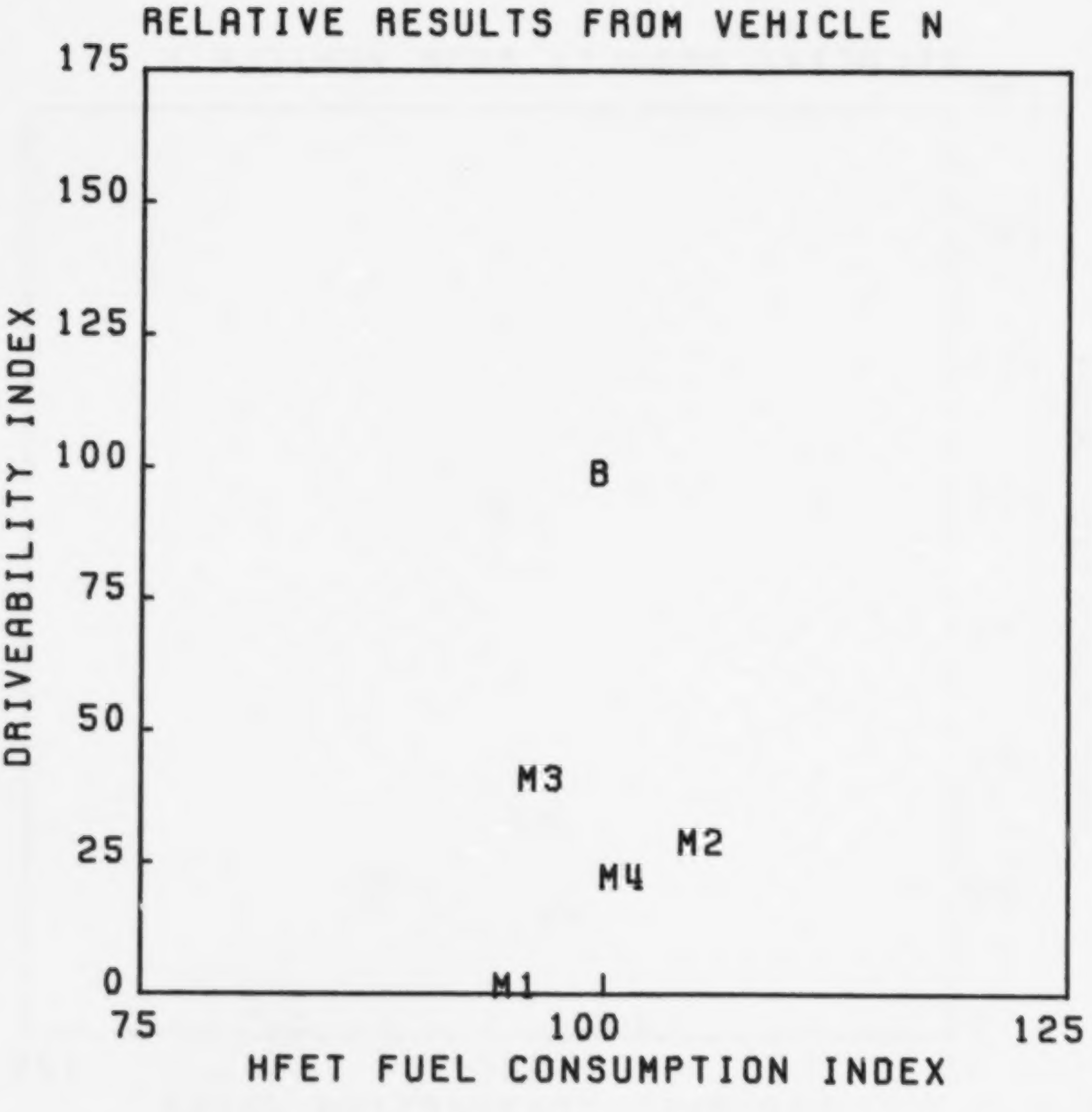

RELATIVE RESULTS FROM VEHICLE M
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
M4
B
MN2
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX

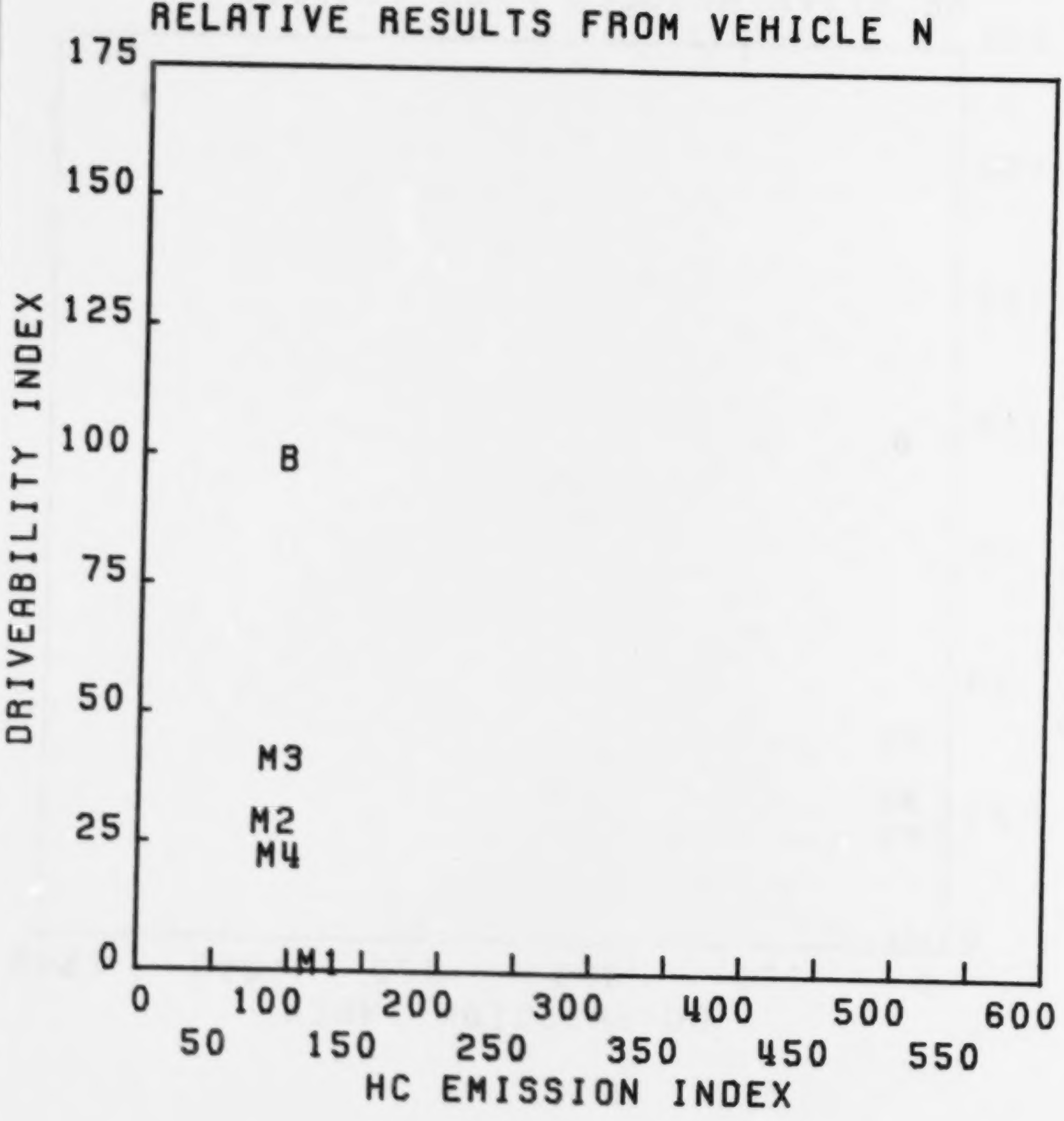

RELATIVE RESULTS FROM VEHICLE M
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
M4
B
M1
M2
0
300
600
900
1200
1500
CO EMISSION INDEX

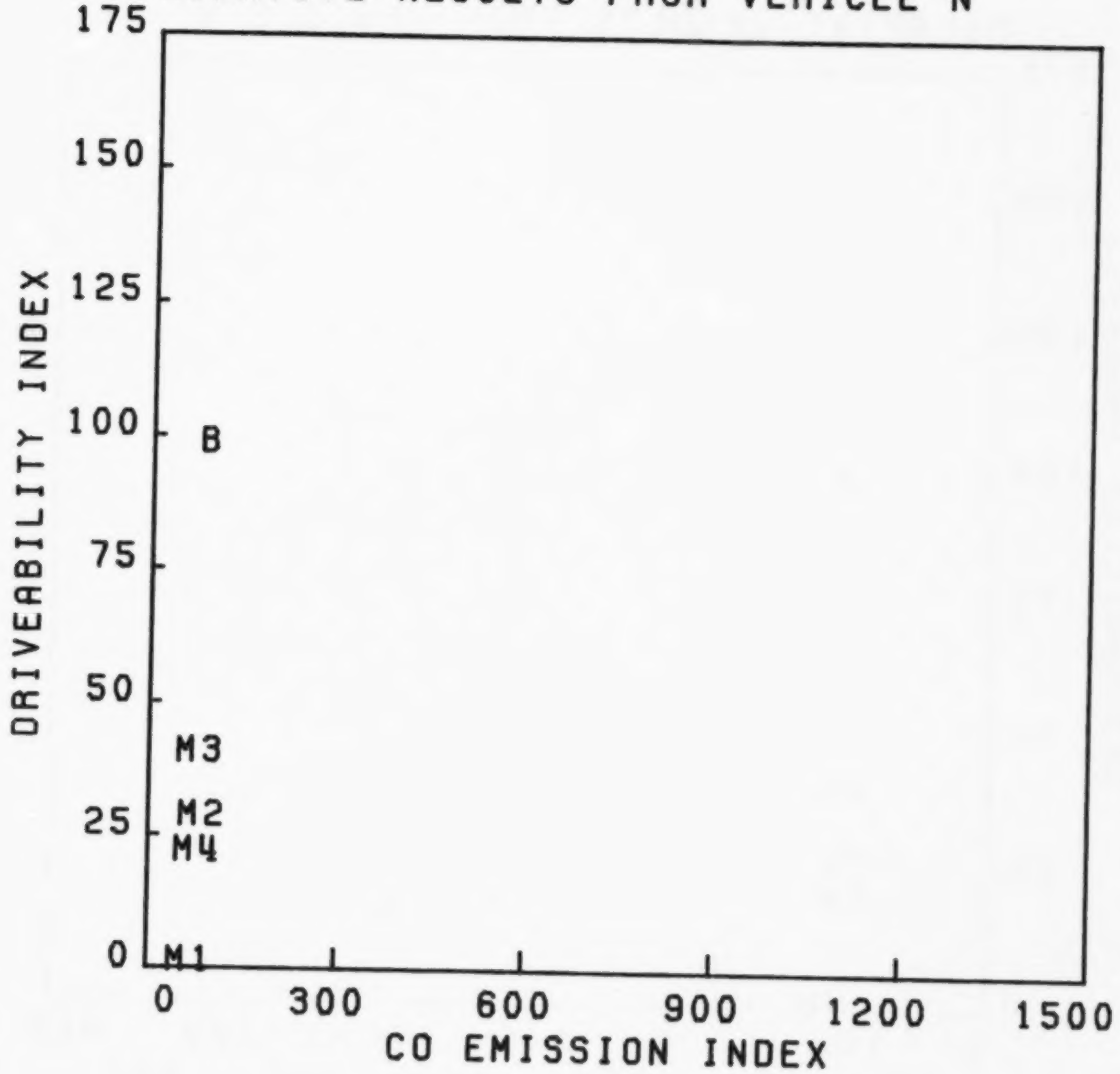

RELATIVE RESULTS FROM VEHICLE M
DRIVEABILITY INDEX
NOX EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M3
M4
B
M2
M1

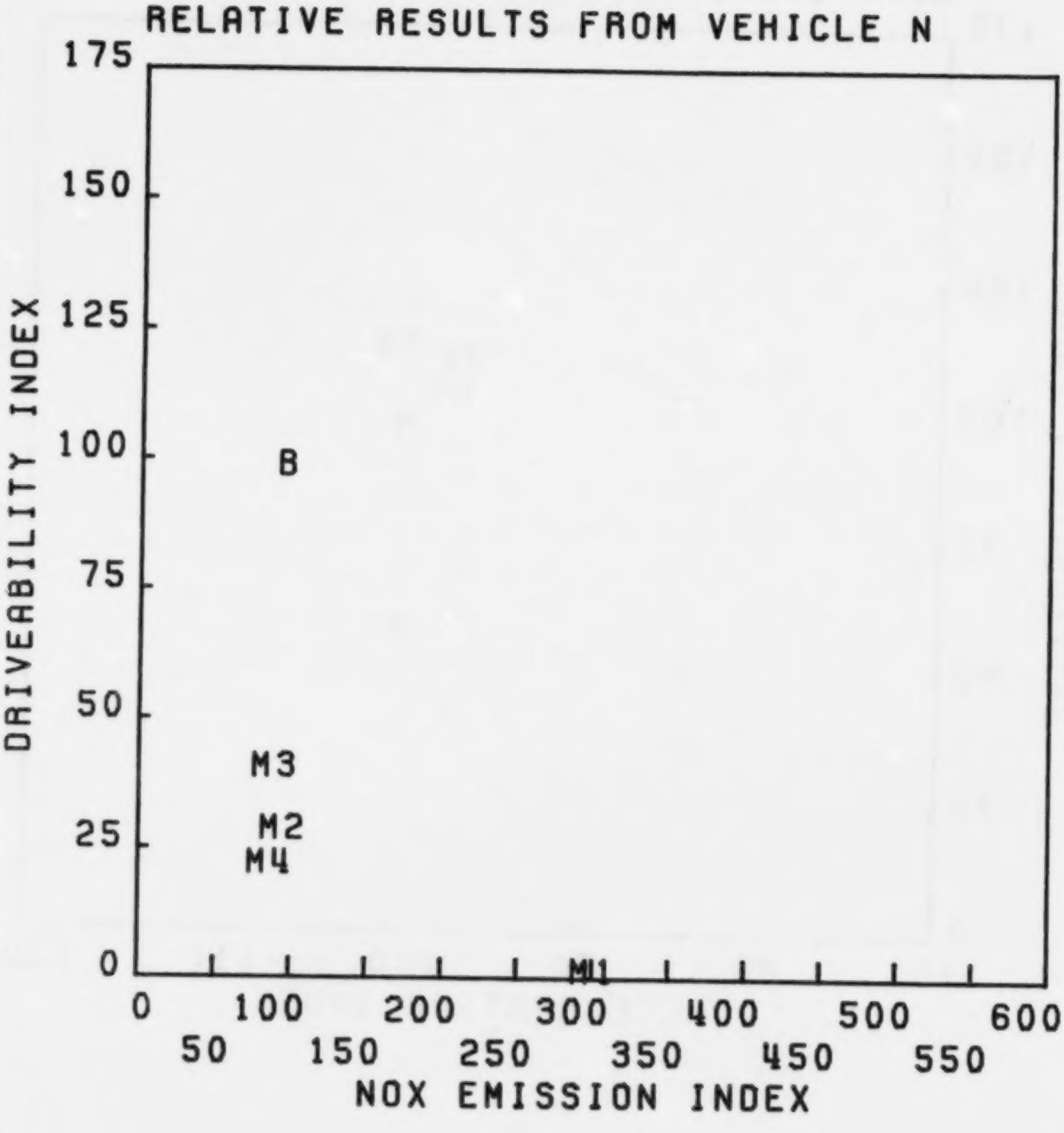

RELATIVE RESULTS FROM VEHICLE N
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
ACCELERATION INDEX
70
80
90
100
110
120
B
M3
M2
M4
M1

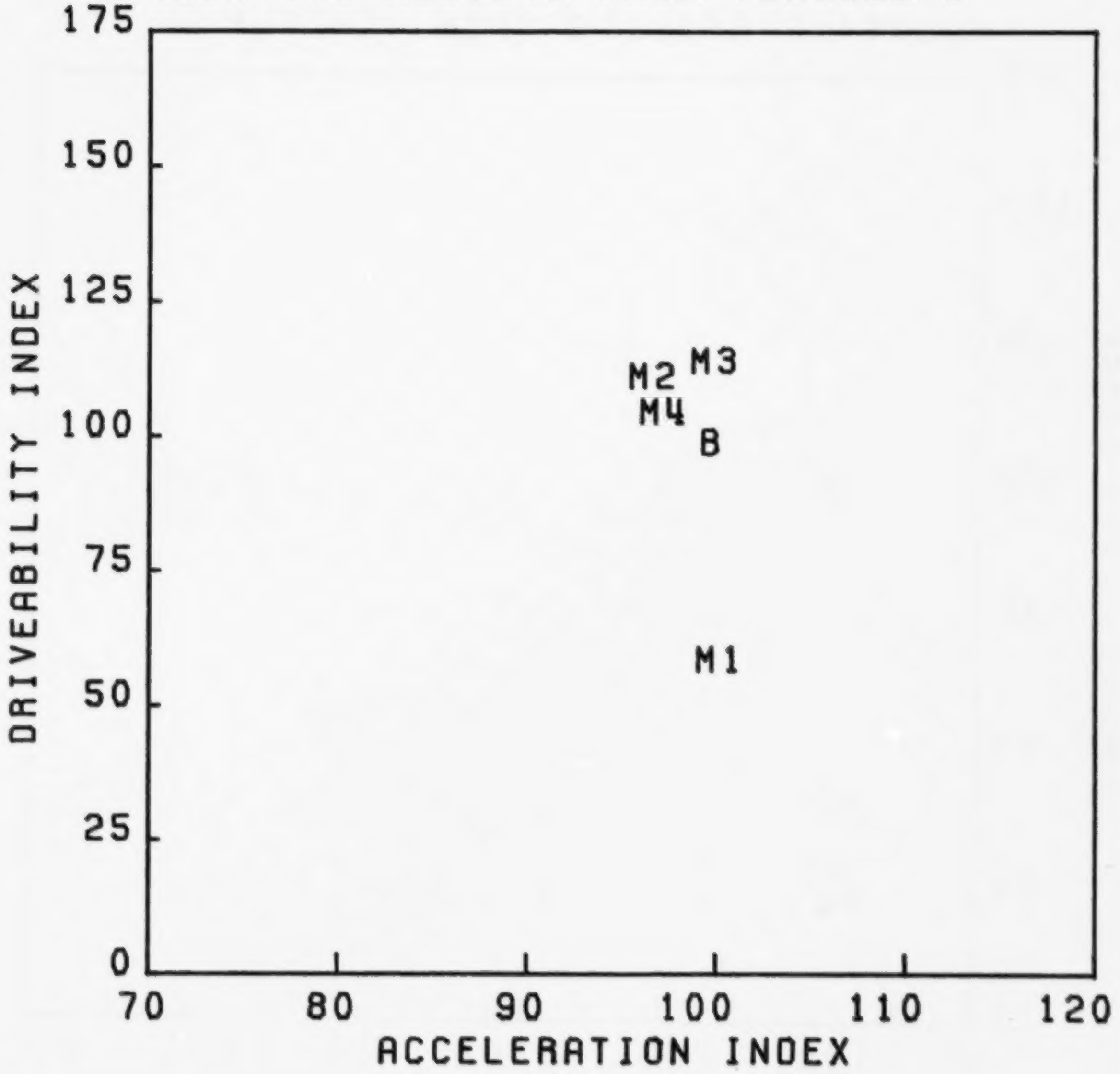

RELATIVE RESULTS FROM VEHICLE N
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
FTP FUEL CONSUMPTION INDEX
B
M3
M2
M4
M1


RELATIVE RESULTS FROM VEHICLE N
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
B
M3
M2
M4
M1
75
100
125
HFET FUEL CONSUMPTION INDEX

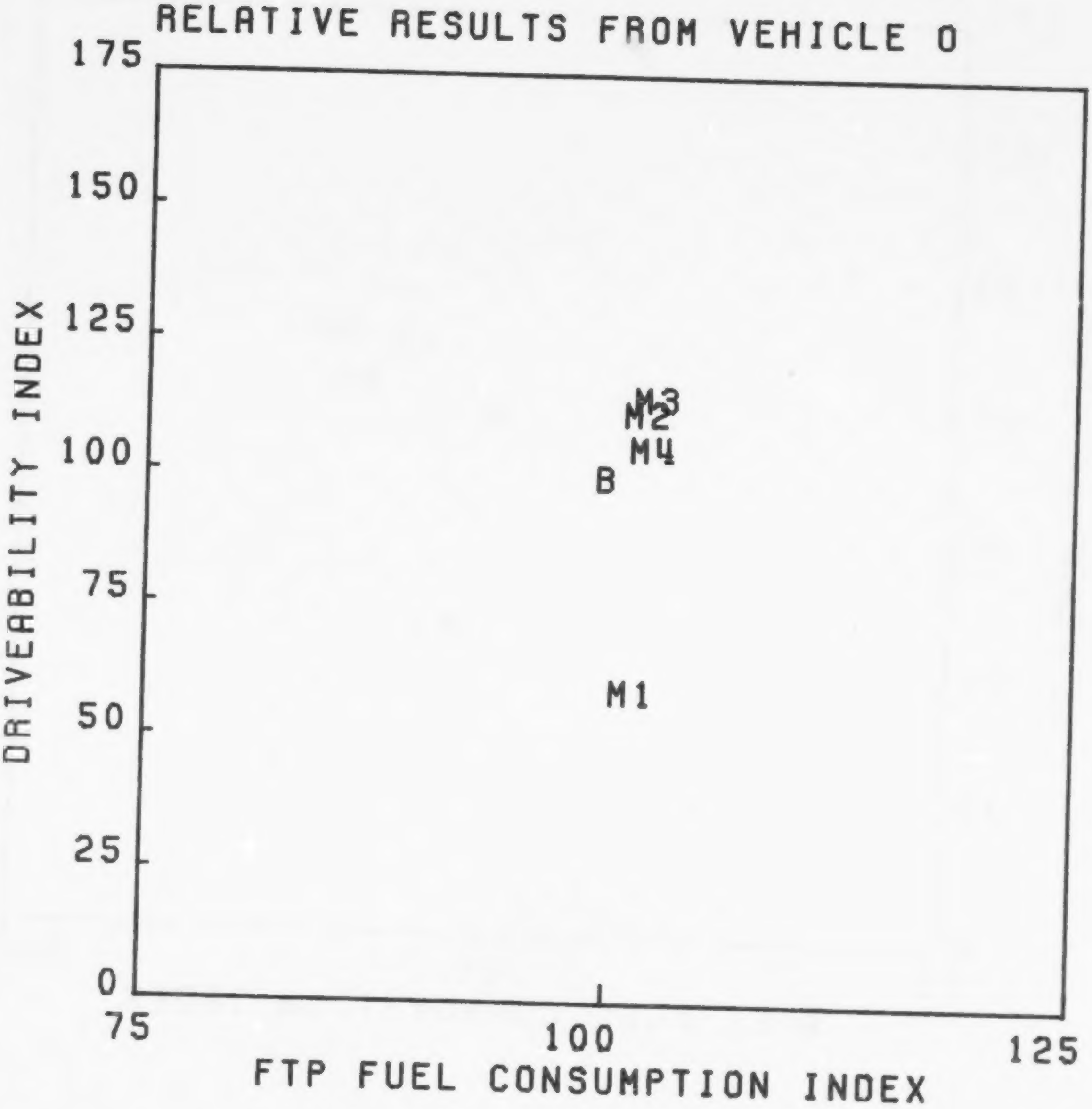

RELATIVE RESULTS FROM VEHICLE N
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX

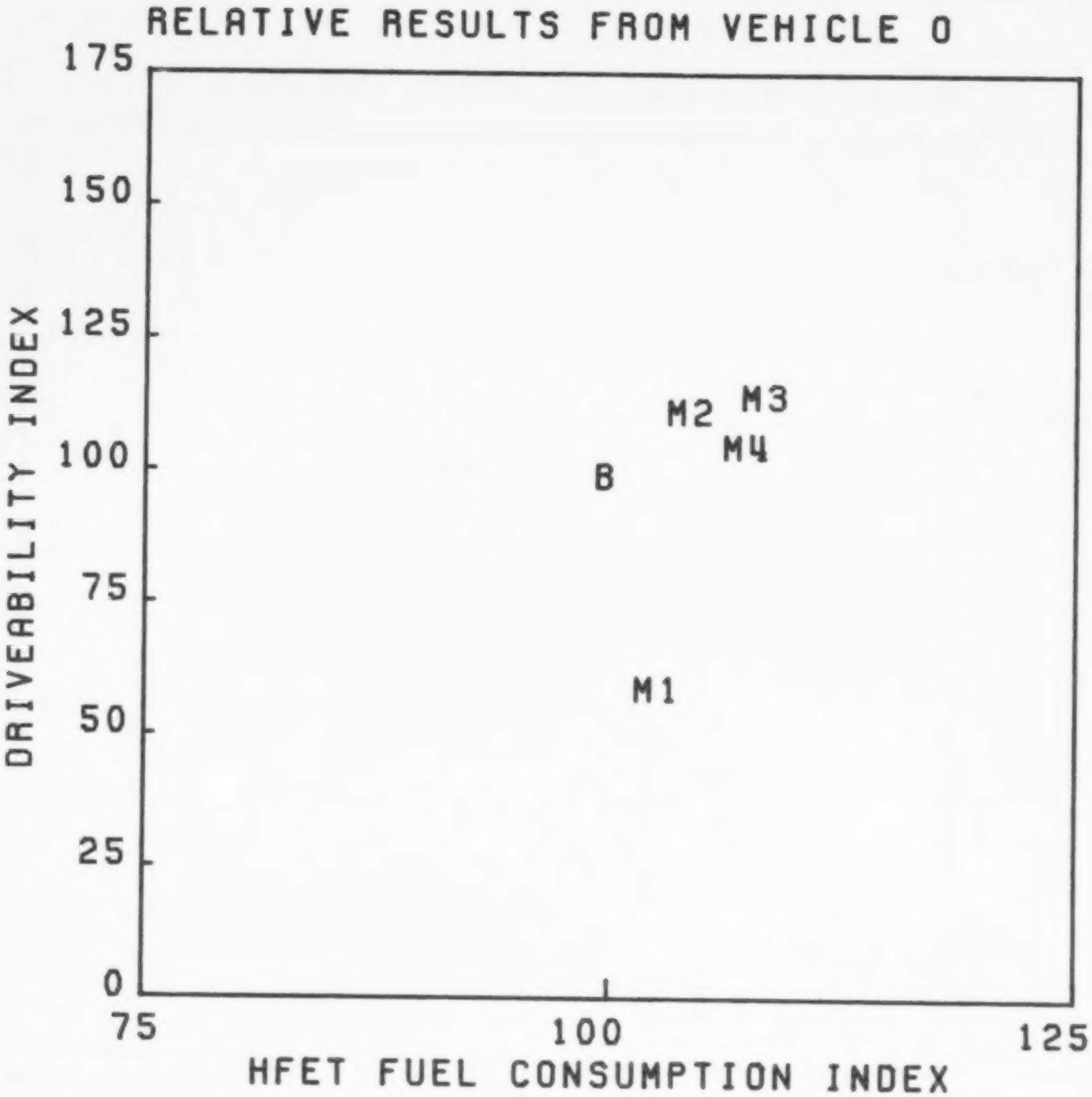

RELATIVE RESULTS FROM VEHICLE N

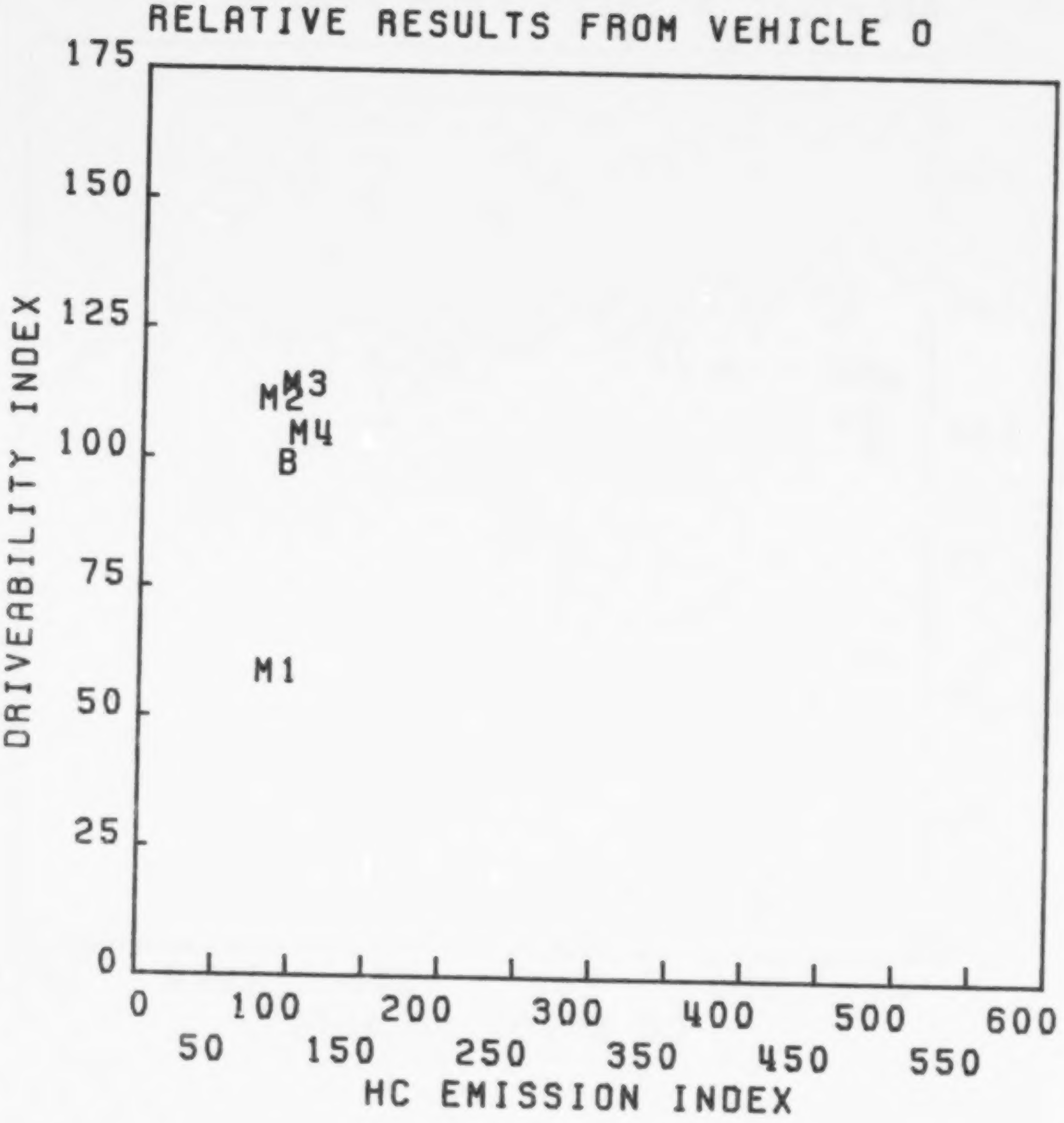

RELATIVE RESULTS FROM VEHICLE N
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
B
M3
M2
M4
M1
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX

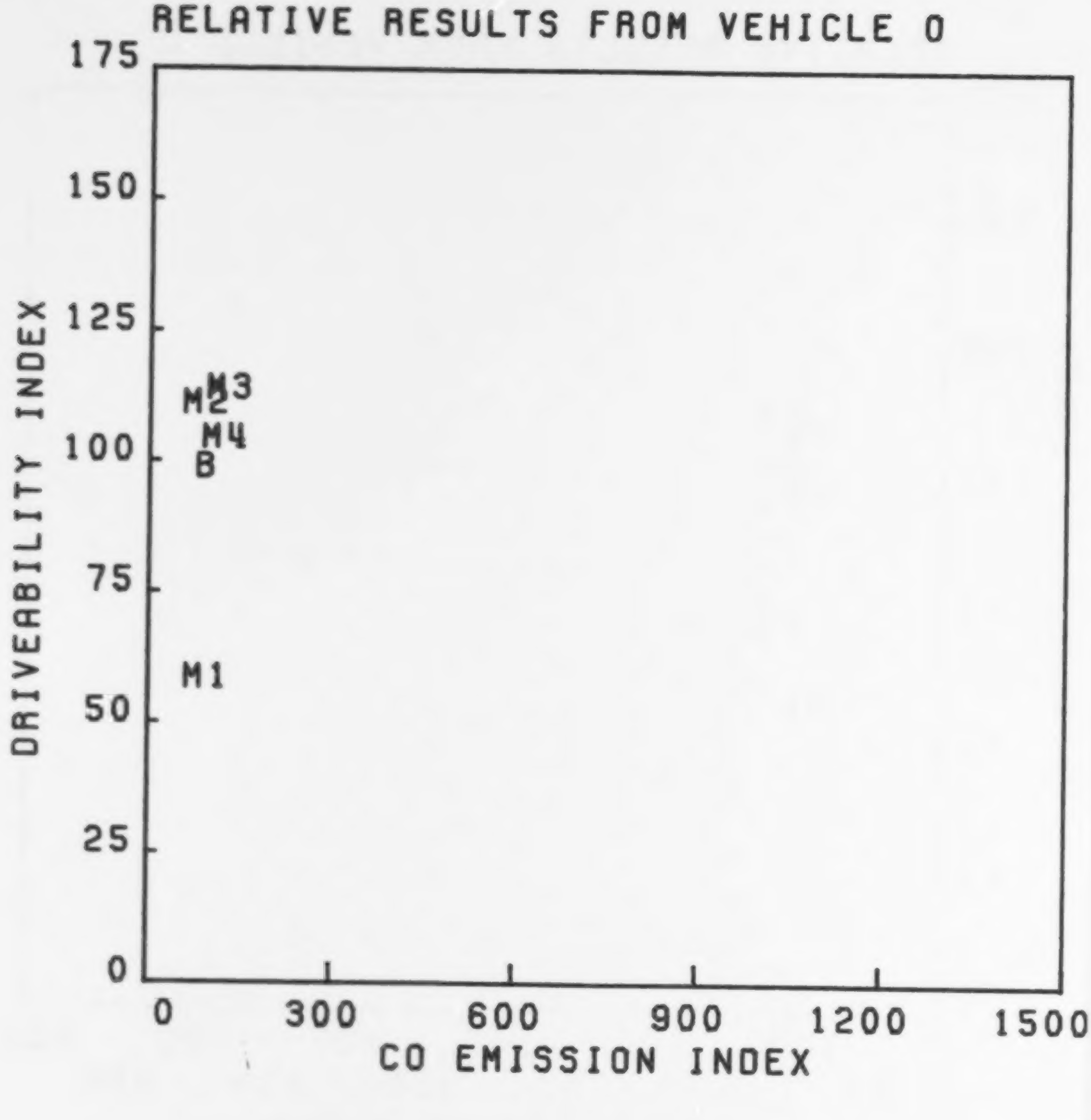


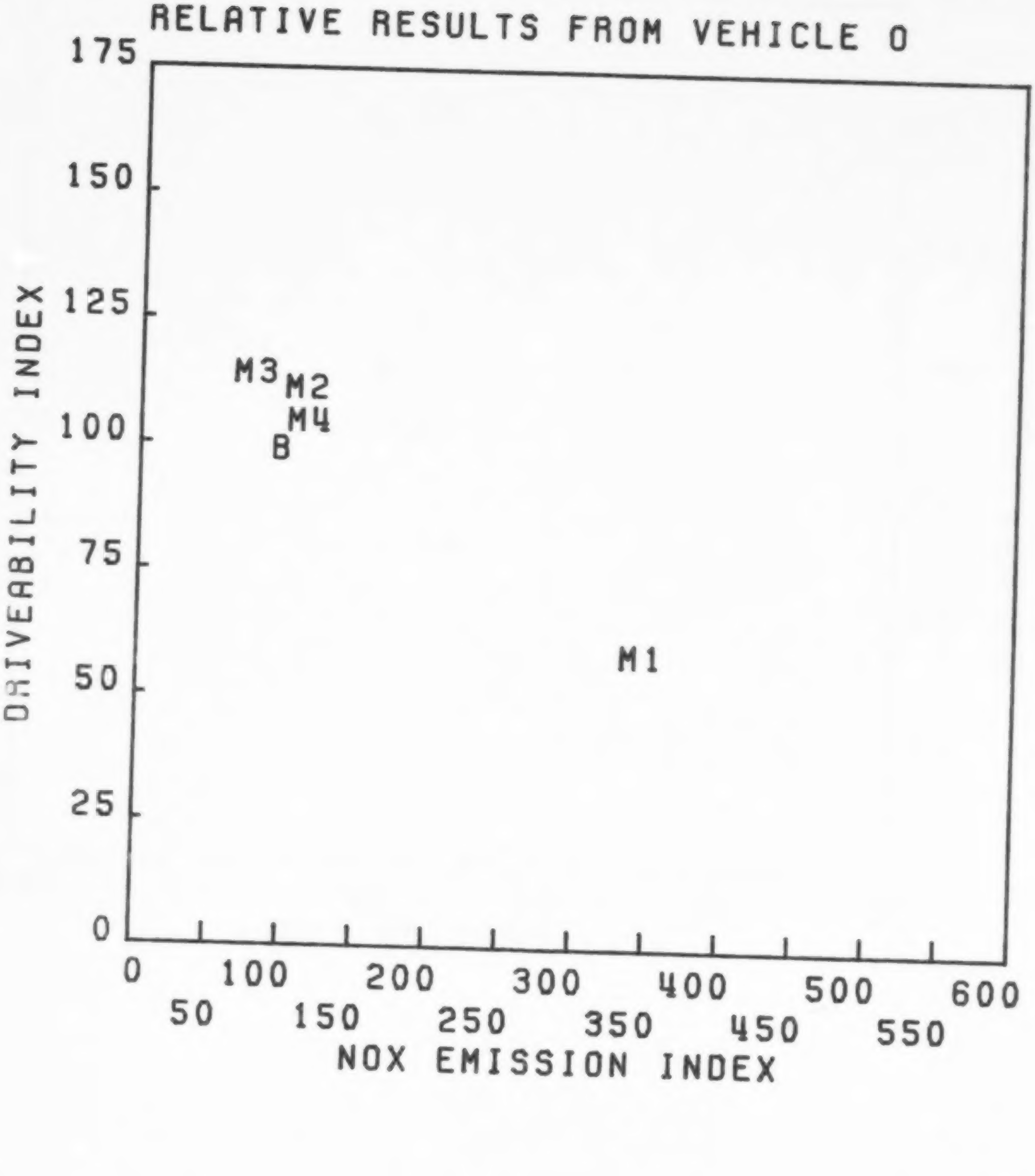
RELATIVE RESULTS FROM VEHICLE O

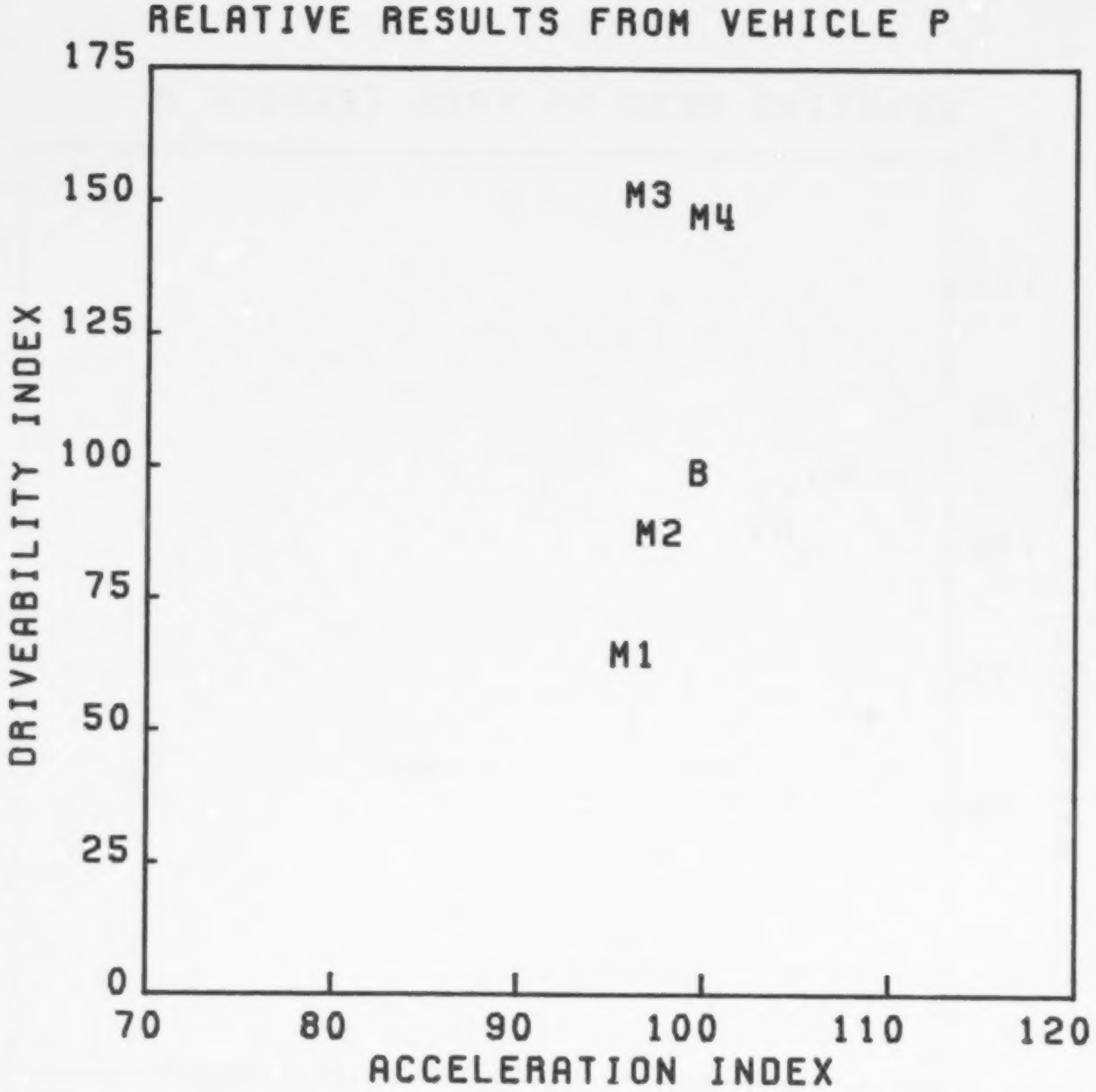

RELATIVE RESULTS FROM VEHICLE O
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M3
M2
M4
B
M1
75
100
125
FTP FUEL CONSUMPTION INDEX

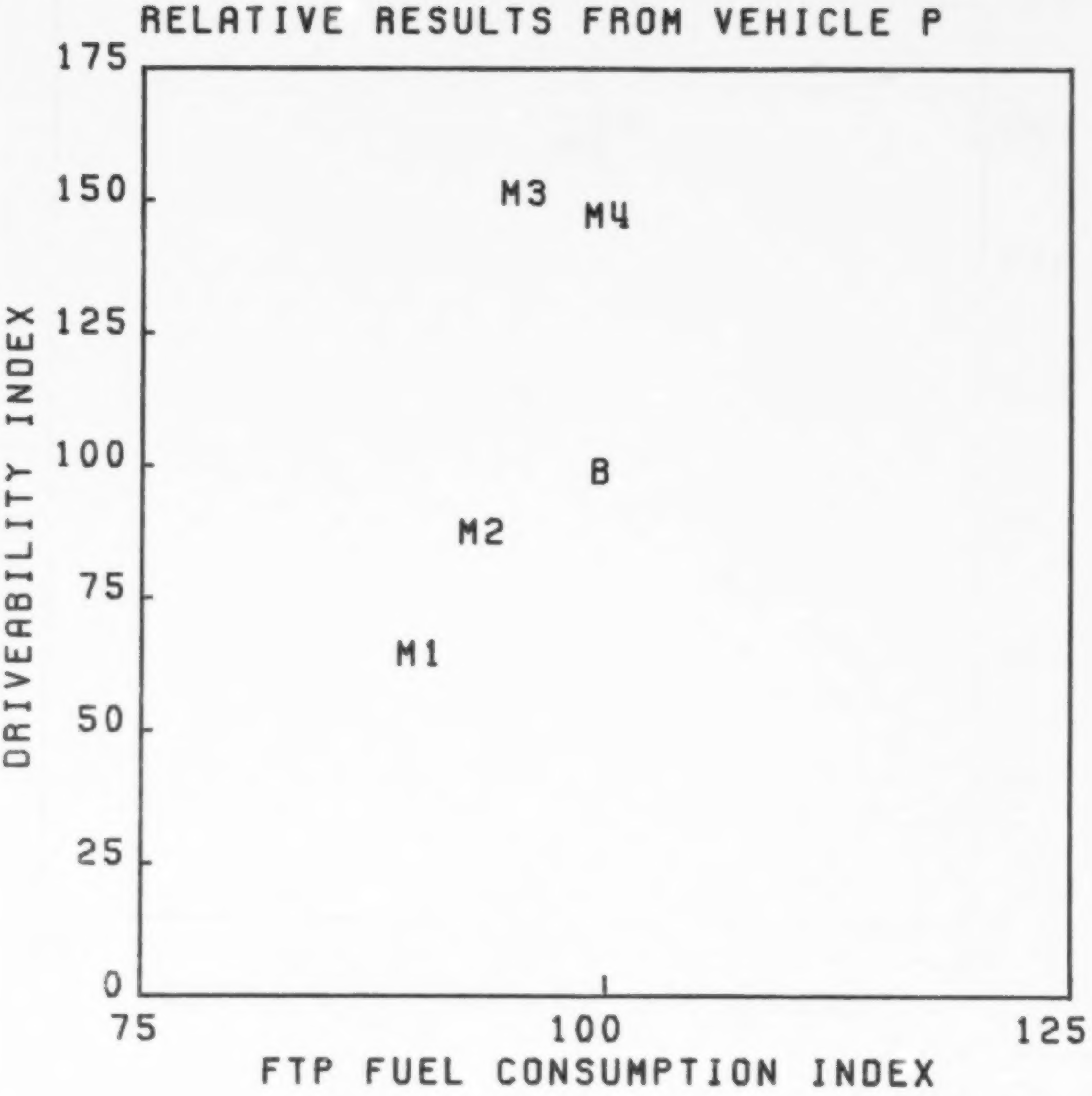

RELATIVE RESULTS FROM VEHICLE O
DRIVEABILITY INDEX
HFET FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
B
M1
M2
M3
M4

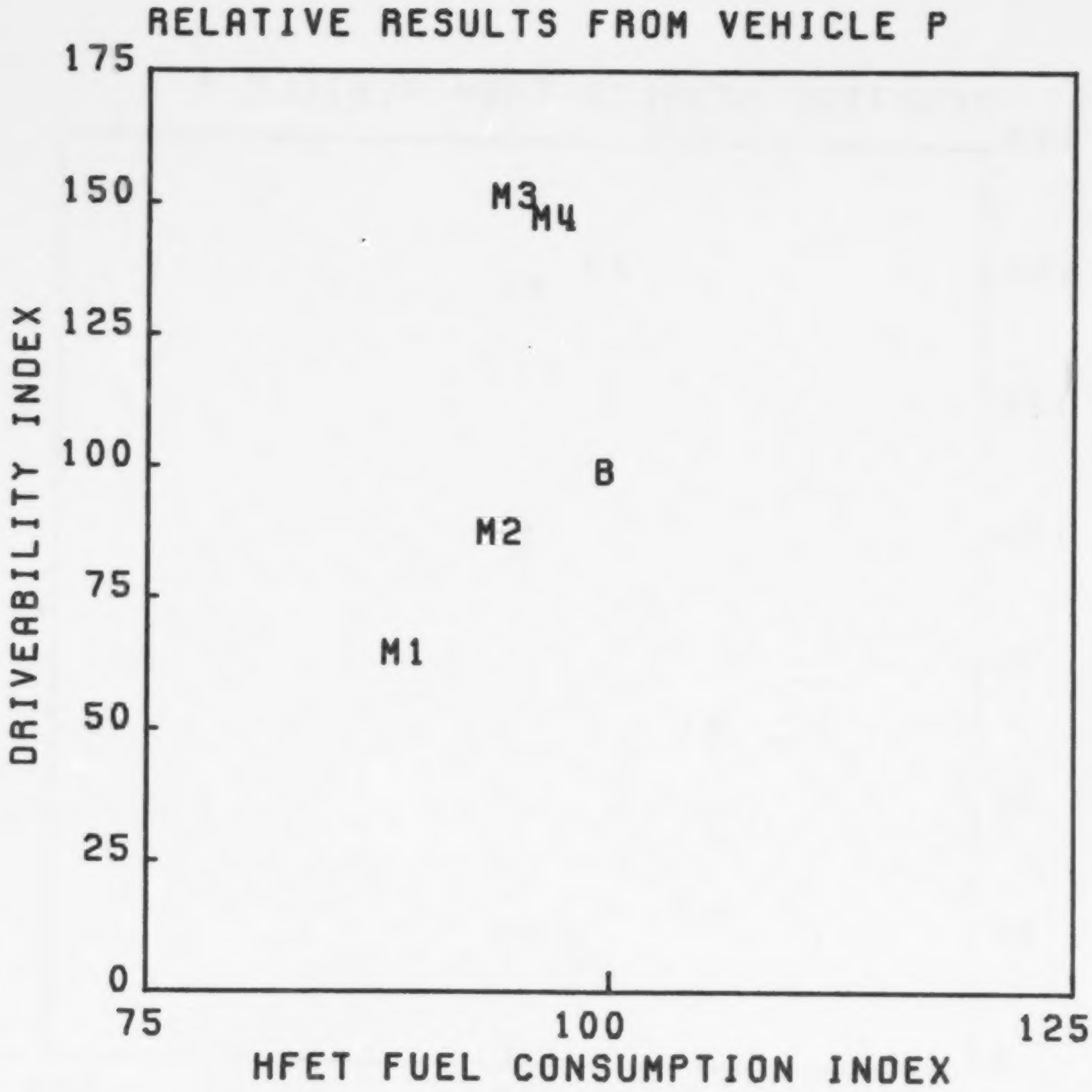

RELATIVE RESULTS FROM VEHICLE O
DRIVEABILITY INDEX
HC EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M3
M2
M4
B
M1

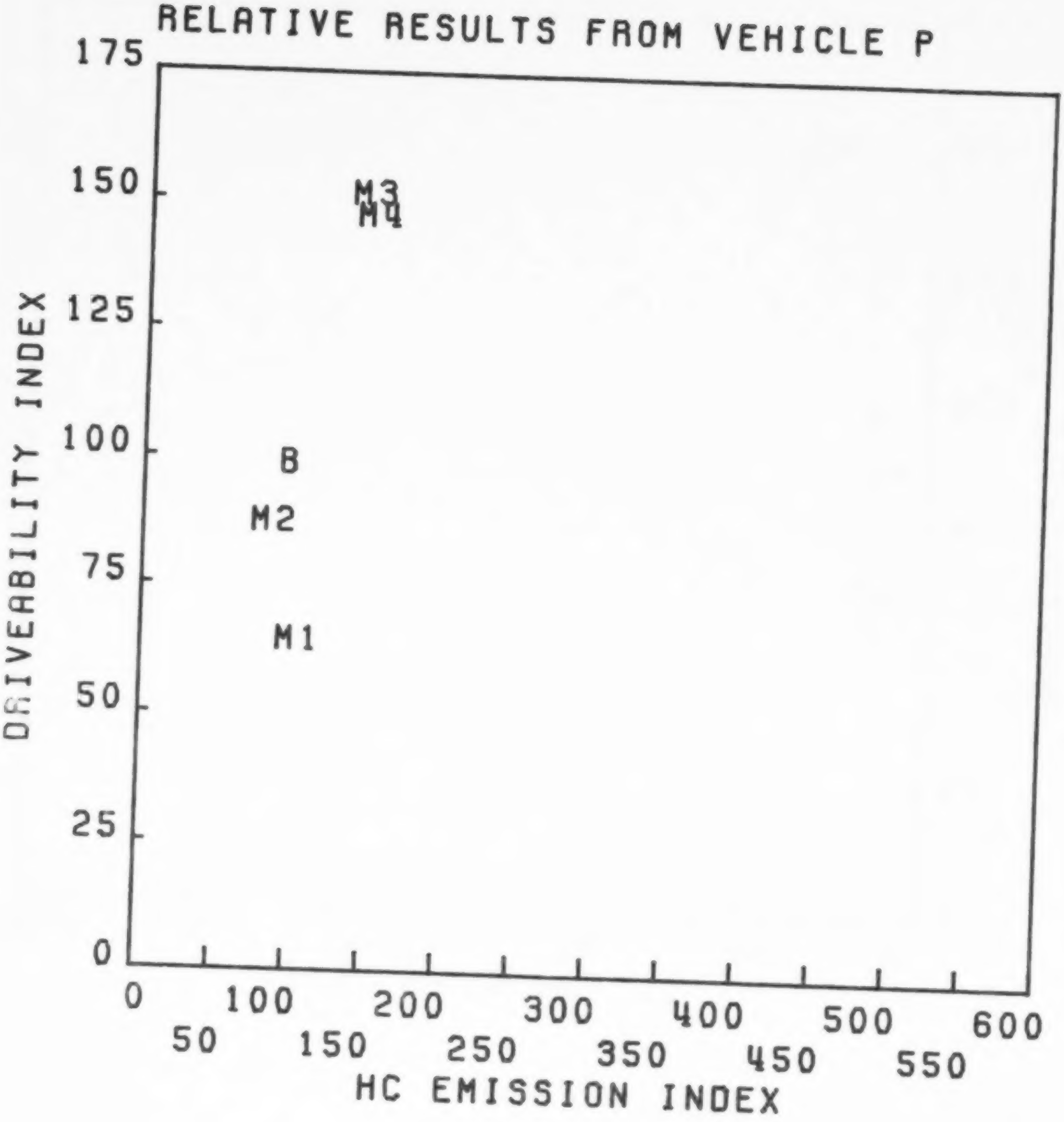

RELATIVE RESULTS FROM VEHICLE O
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
0
300
600
900
1200
1500
CO EMISSION INDEX
M3
M2
M4
B
M1

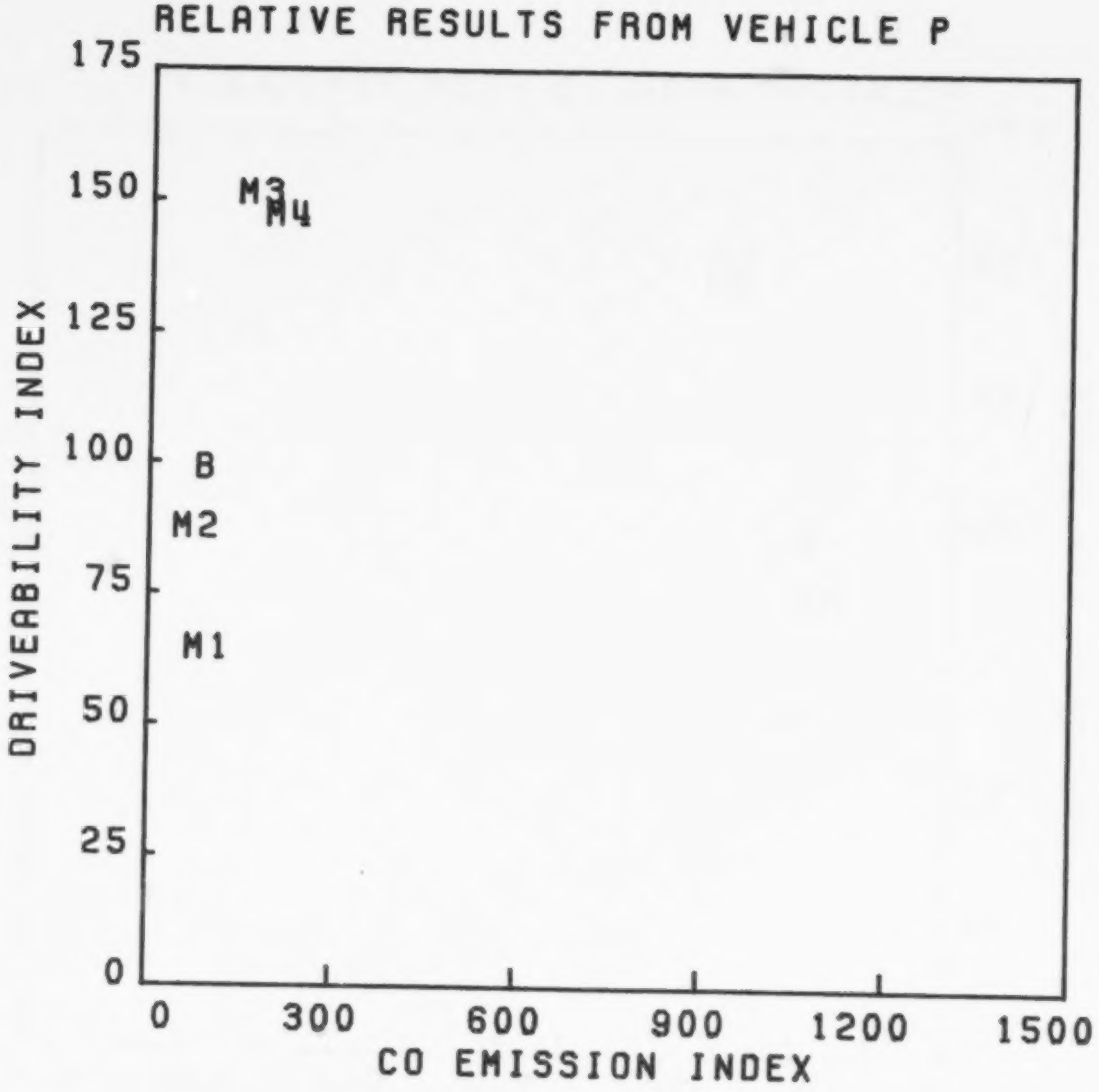

RELATIVE RESULTS FROM VEHICLE O
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
M2
M4
B
M1
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX

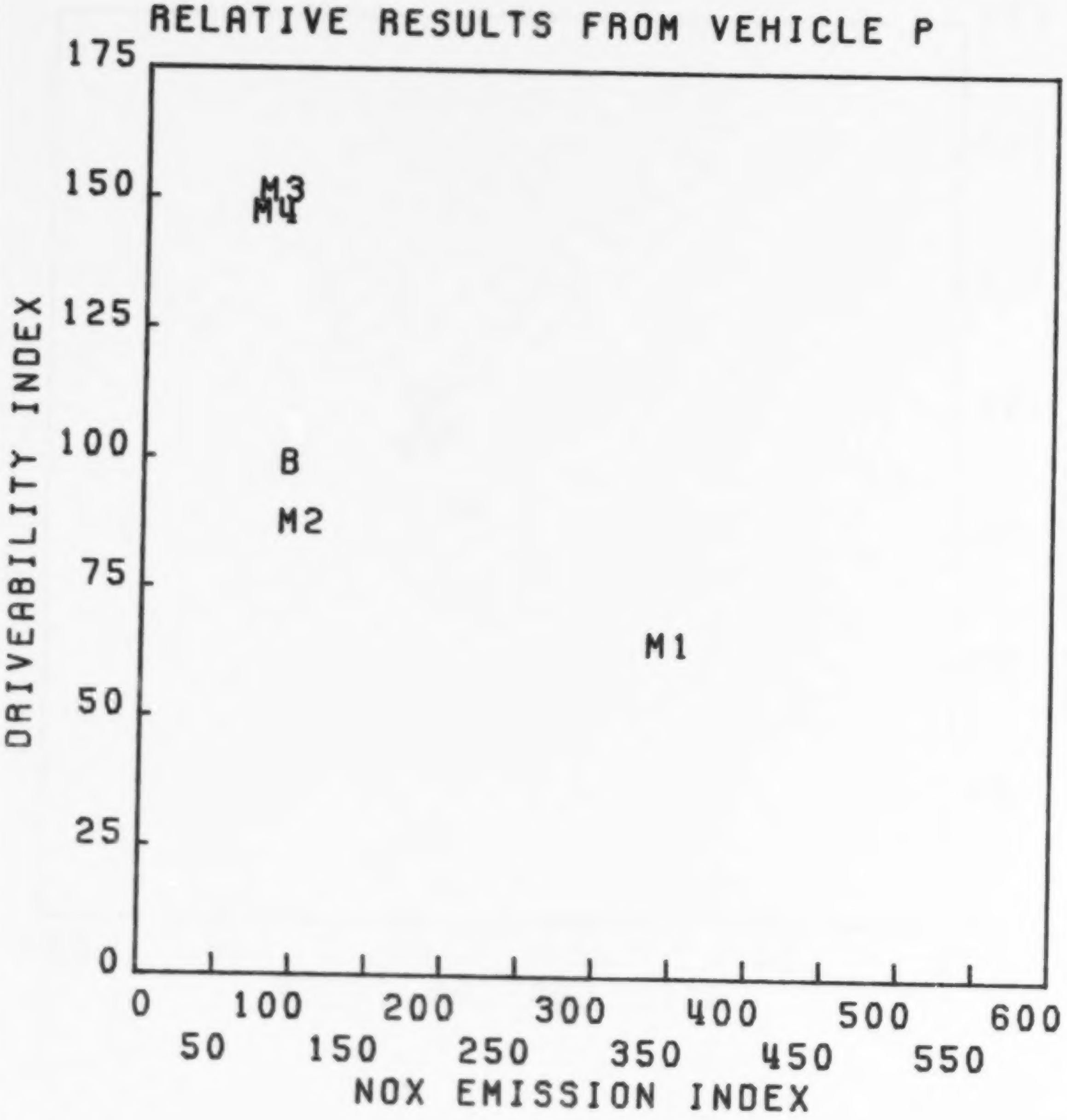

RELATIVE RESULTS FROM VEHICLE P
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
ACCELERATION INDEX
70
80
90
100
110
120
M3
M4
B
M2
M1

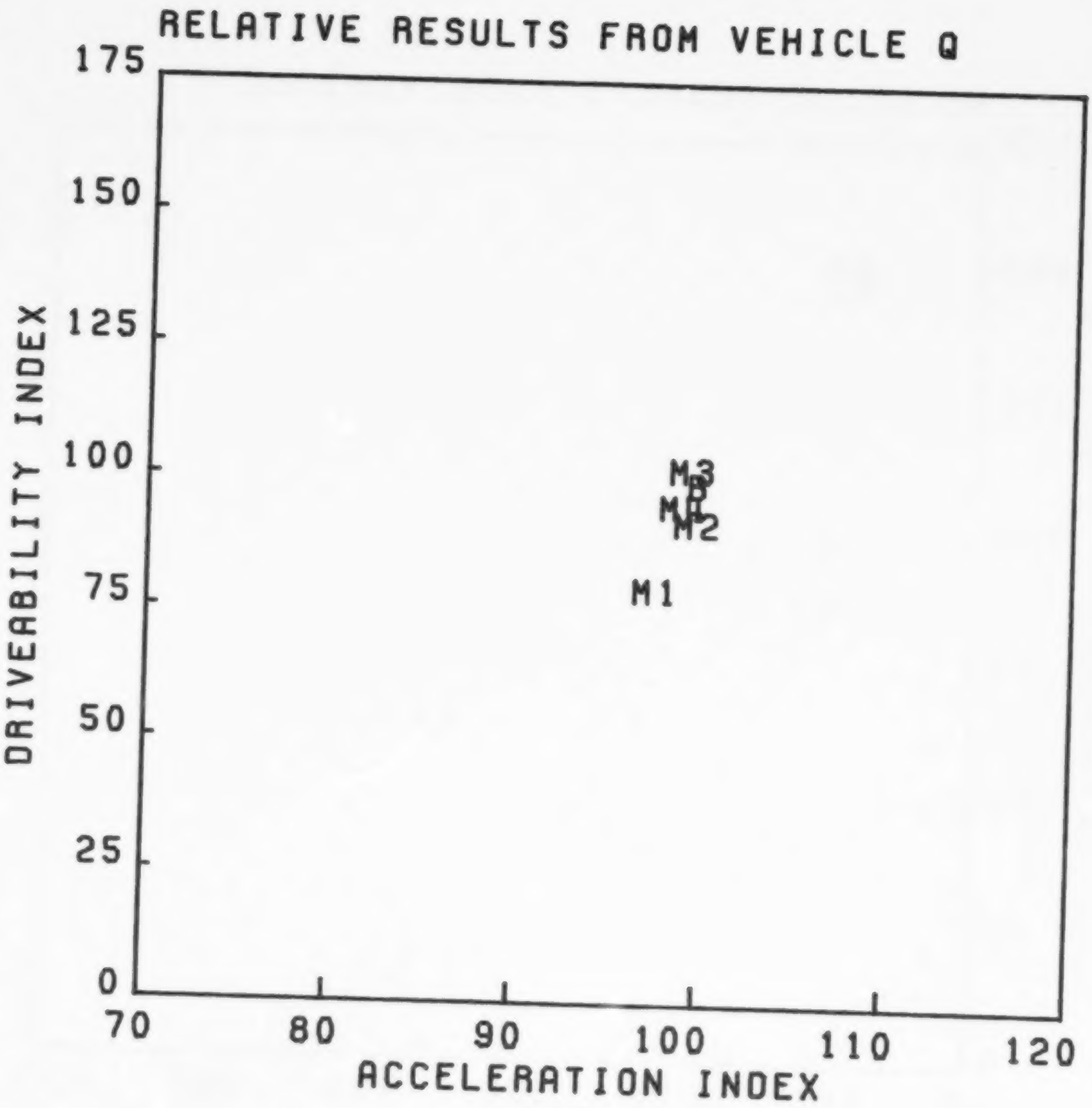

RELATIVE RESULTS FROM VEHICLE P
DRIVEABILITY INDEX
FTP FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
M3
M4
B
M2
M1

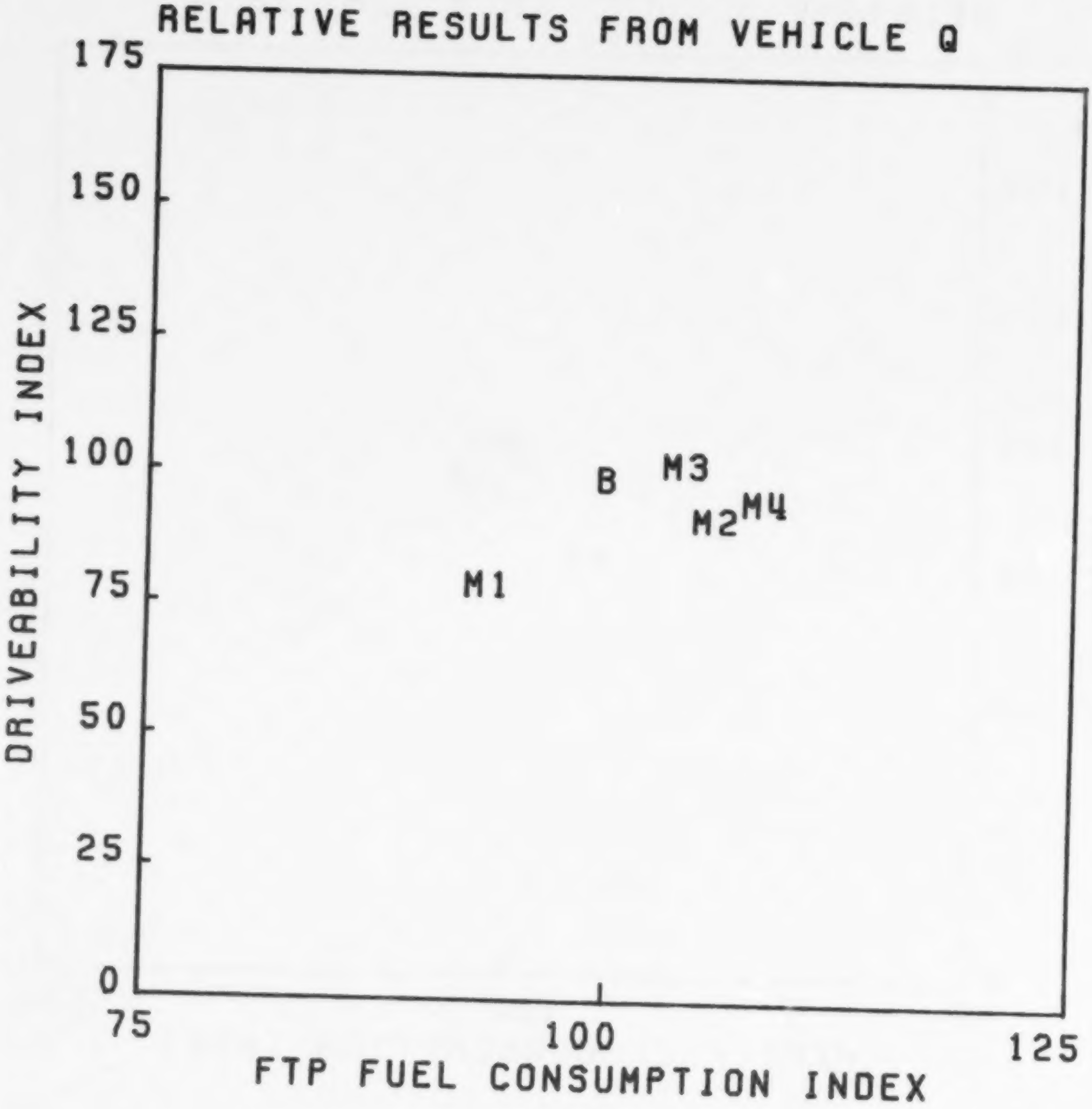

RELATIVE RESULTS FROM VEHICLE P
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
HFET FUEL CONSUMPTION INDEX
M3
M4
B
M2
M1

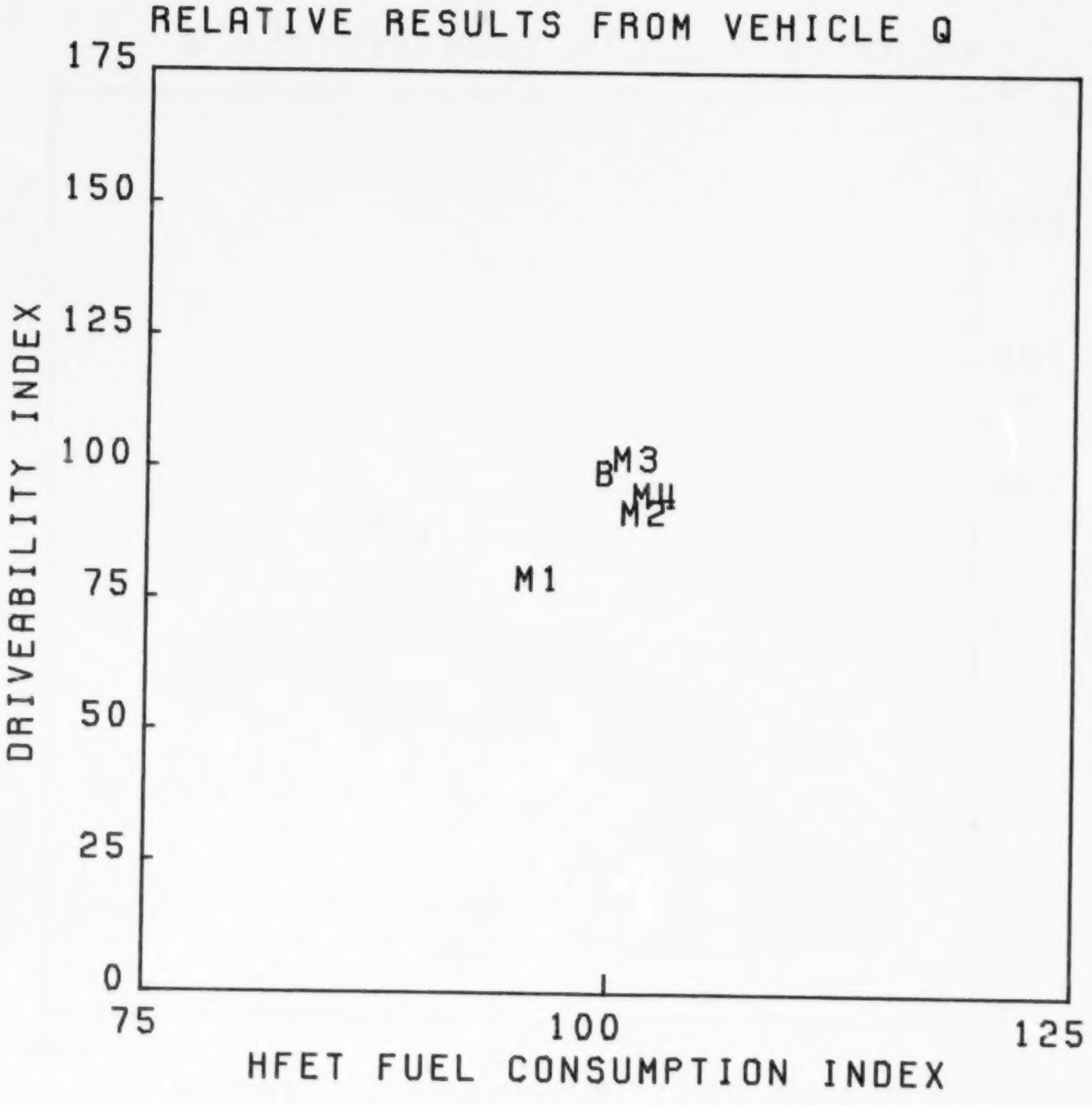

RELATIVE RESULTS FROM VEHICLE P
DRIVEABILITY INDEX
HC EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M3
M4
B
M2
M1

RELATIVE RESULTS FROM VEHICLE P
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
M4
B
M2
M1
0
300
600
900
1200
1500
CO EMISSION INDEX

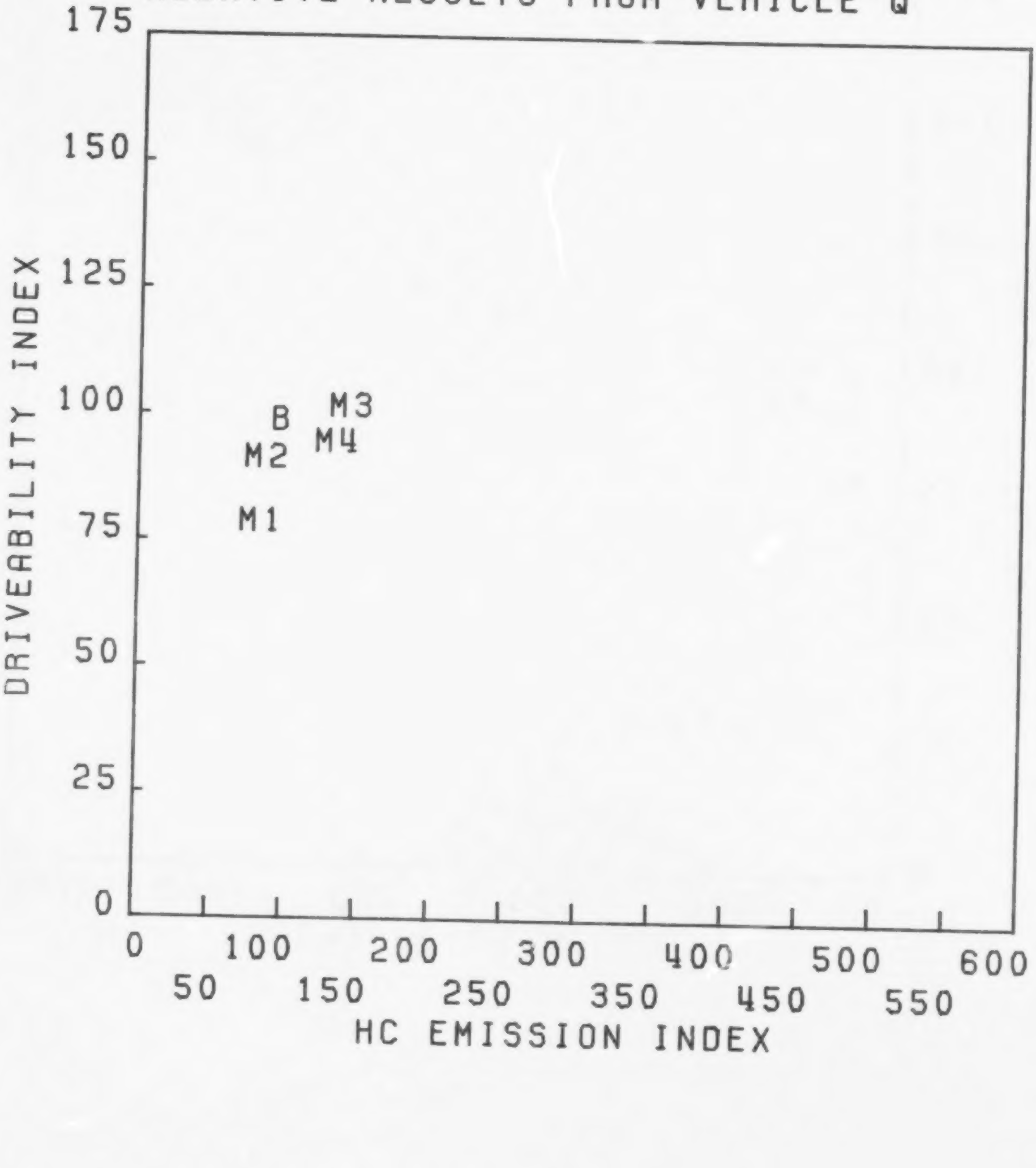

RELATIVE RESULTS FROM VEHICLE P
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
M4
B
M2
M1
0
100
200
300
400
500
600
50
150
250
350
450
550
NOX EMISSION INDEX


RELATIVE RESULTS FROM VEHICLE Q
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
ACCELERATION INDEX
70
80
90
100
110
120
M3
B
M1
M2
M1

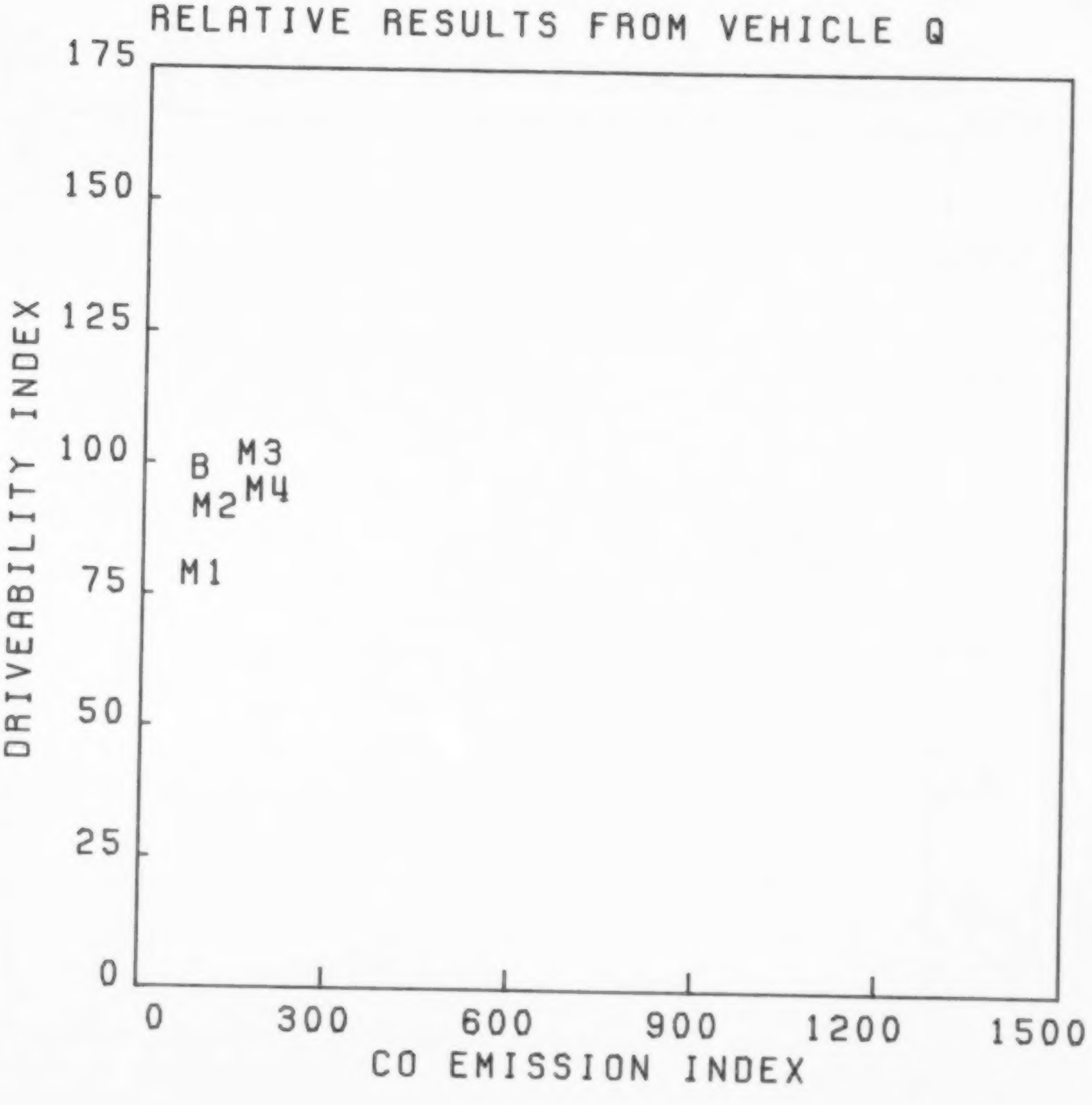

RELATIVE RESULTS FROM VEHICLE Q
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
75
100
125
FTP FUEL CONSUMPTION INDEX
B
M3
M2
M4
M1

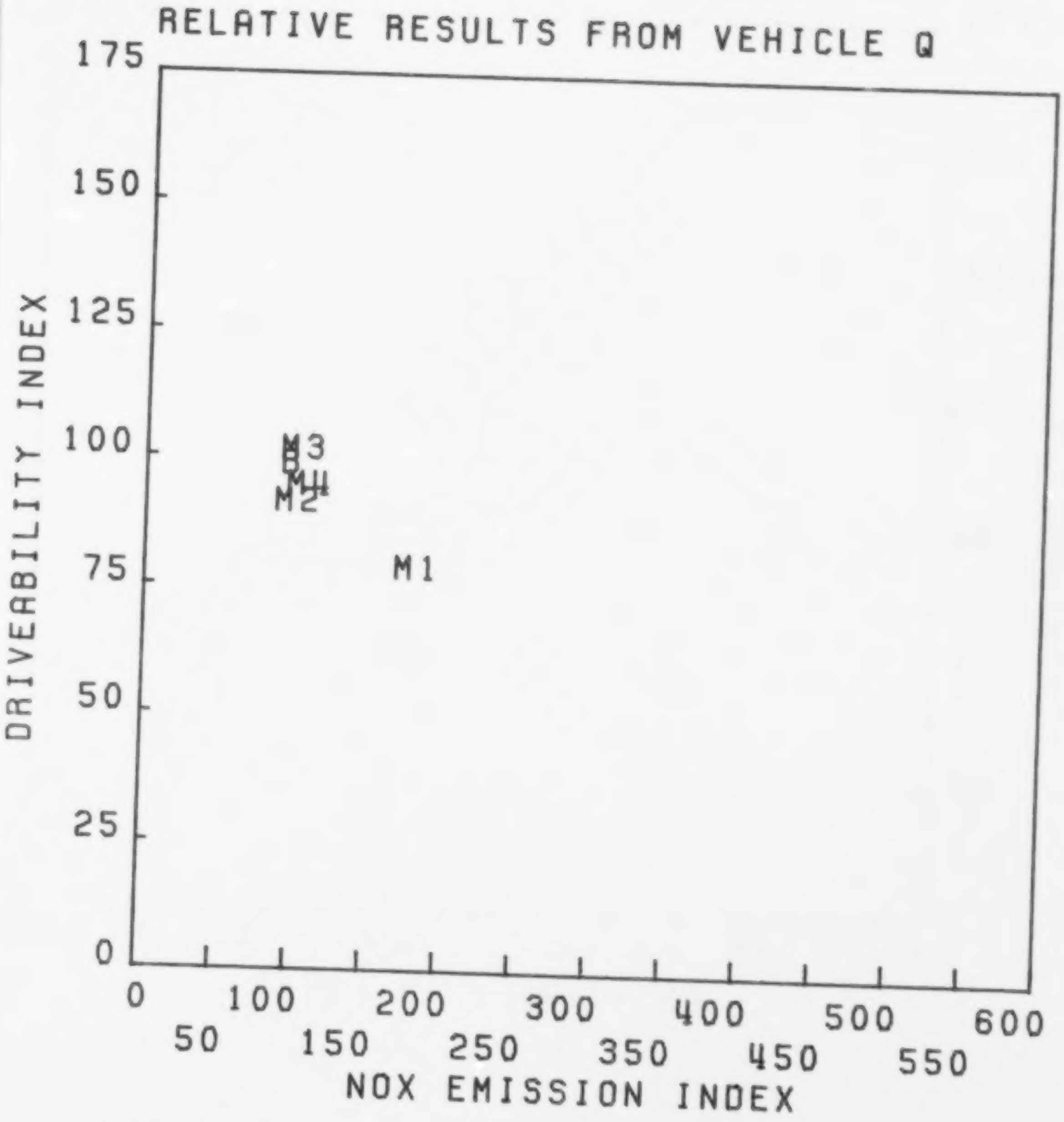


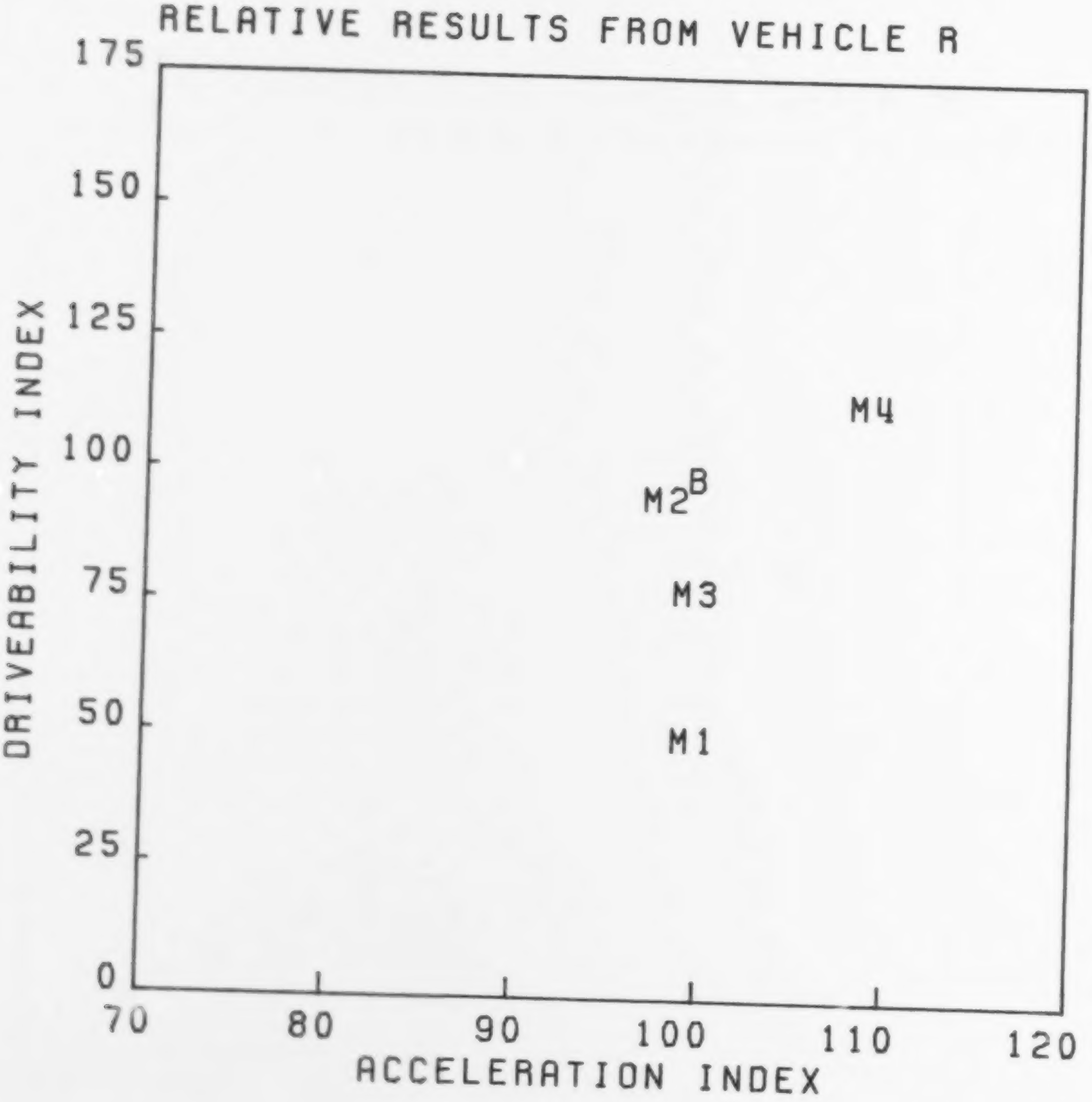
RELATIVE RESULTS FROM VEHICLE Q

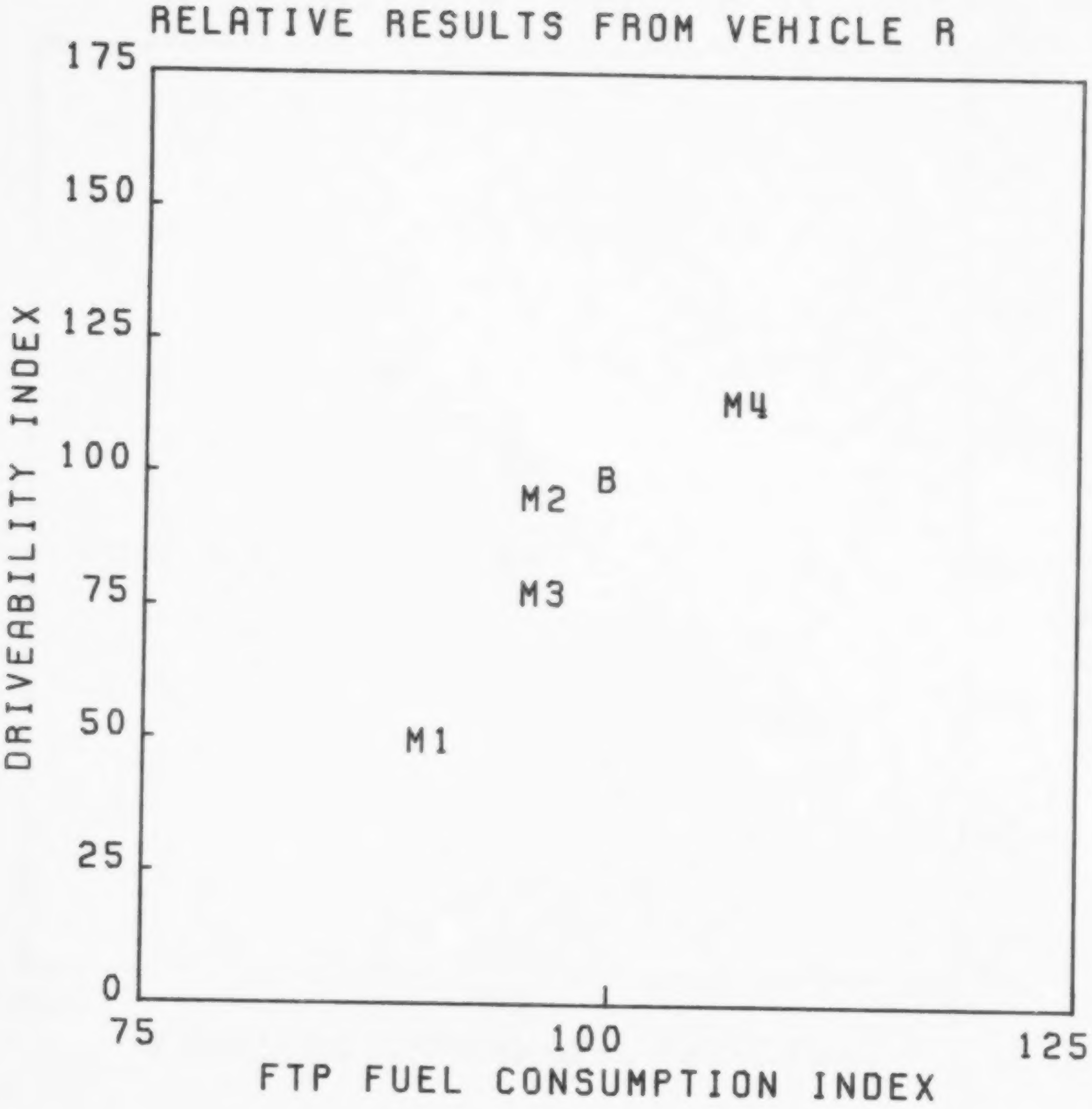


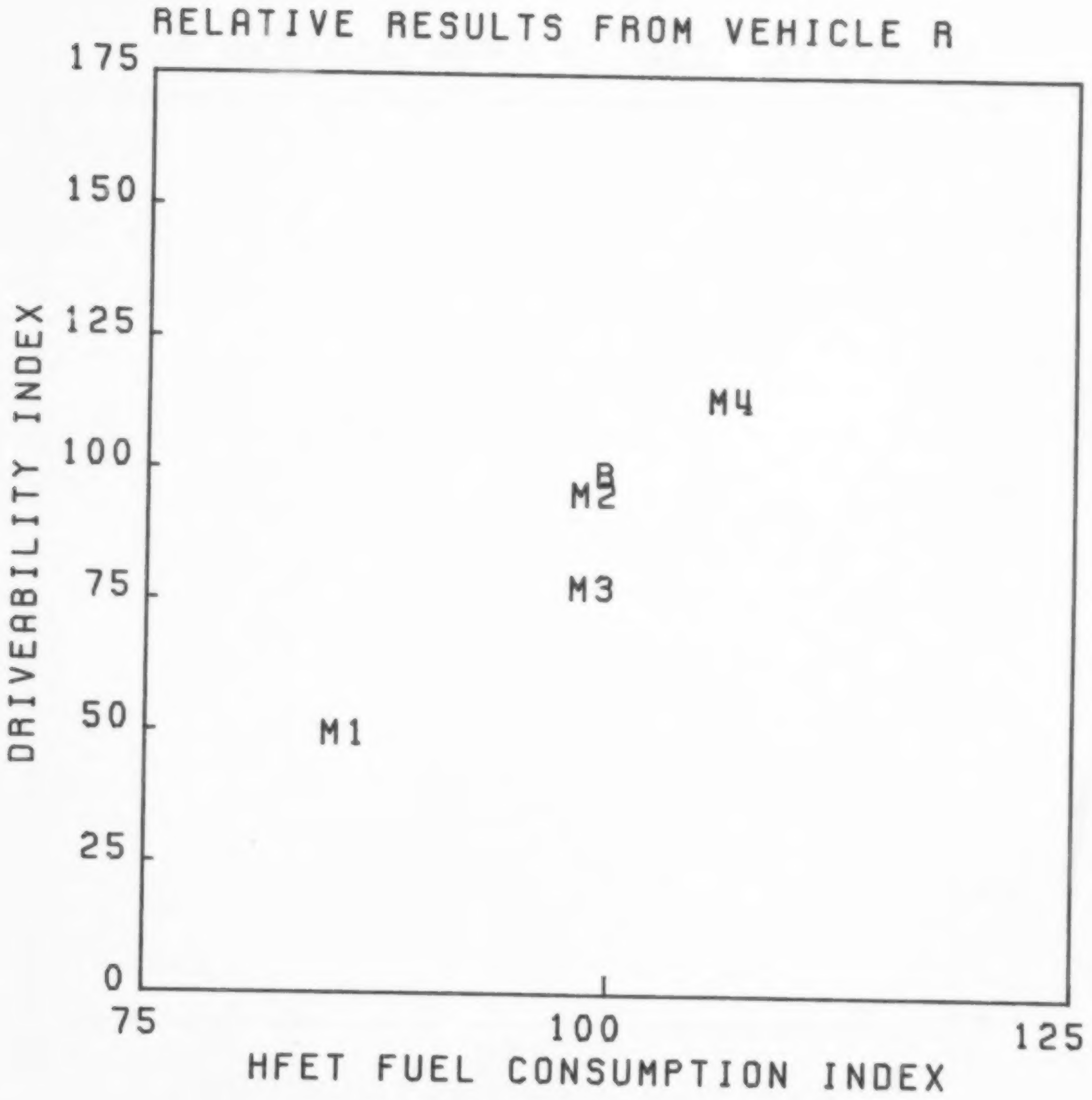
RELATIVE RESULTS FROM VEHICLE Q

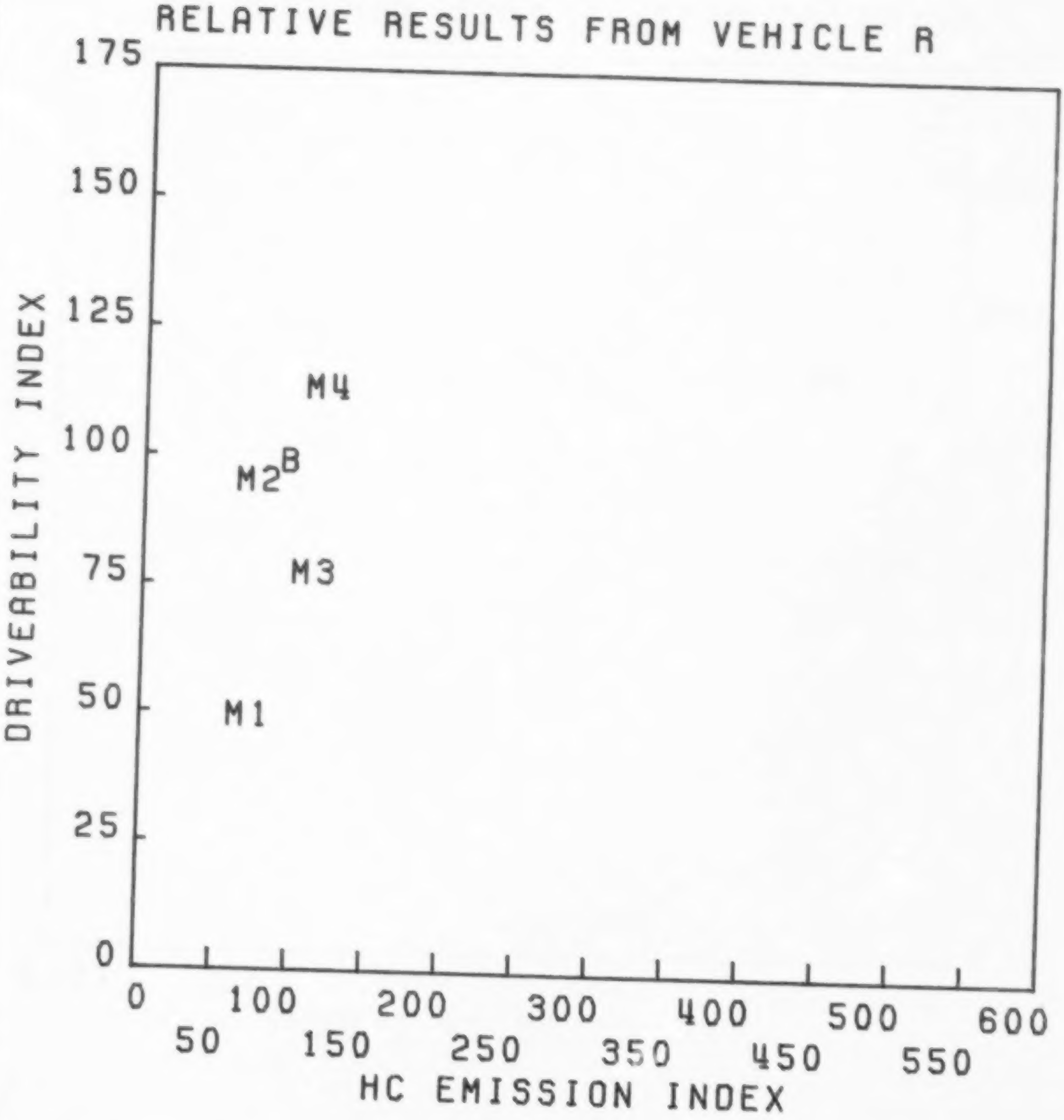

RELATIVE RESULTS FROM VEHICLE Q
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
B
M3
M2
M4
M1
0
300
600
900
1200
1500
CO EMISSION INDEX

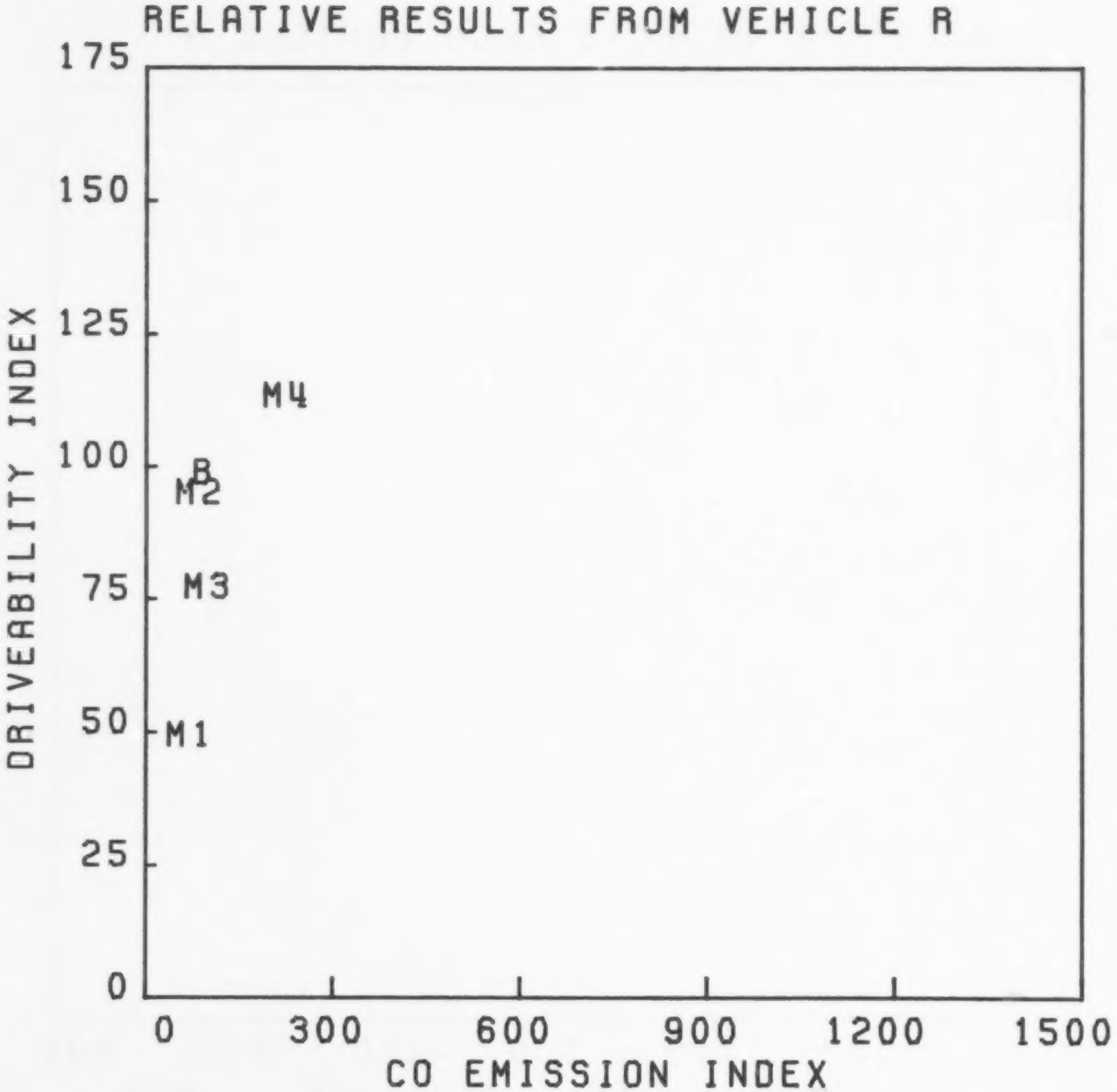

RELATIVE RESULTS FROM VEHICLE Q
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
NOX EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
M3
B
M4
M2
M1

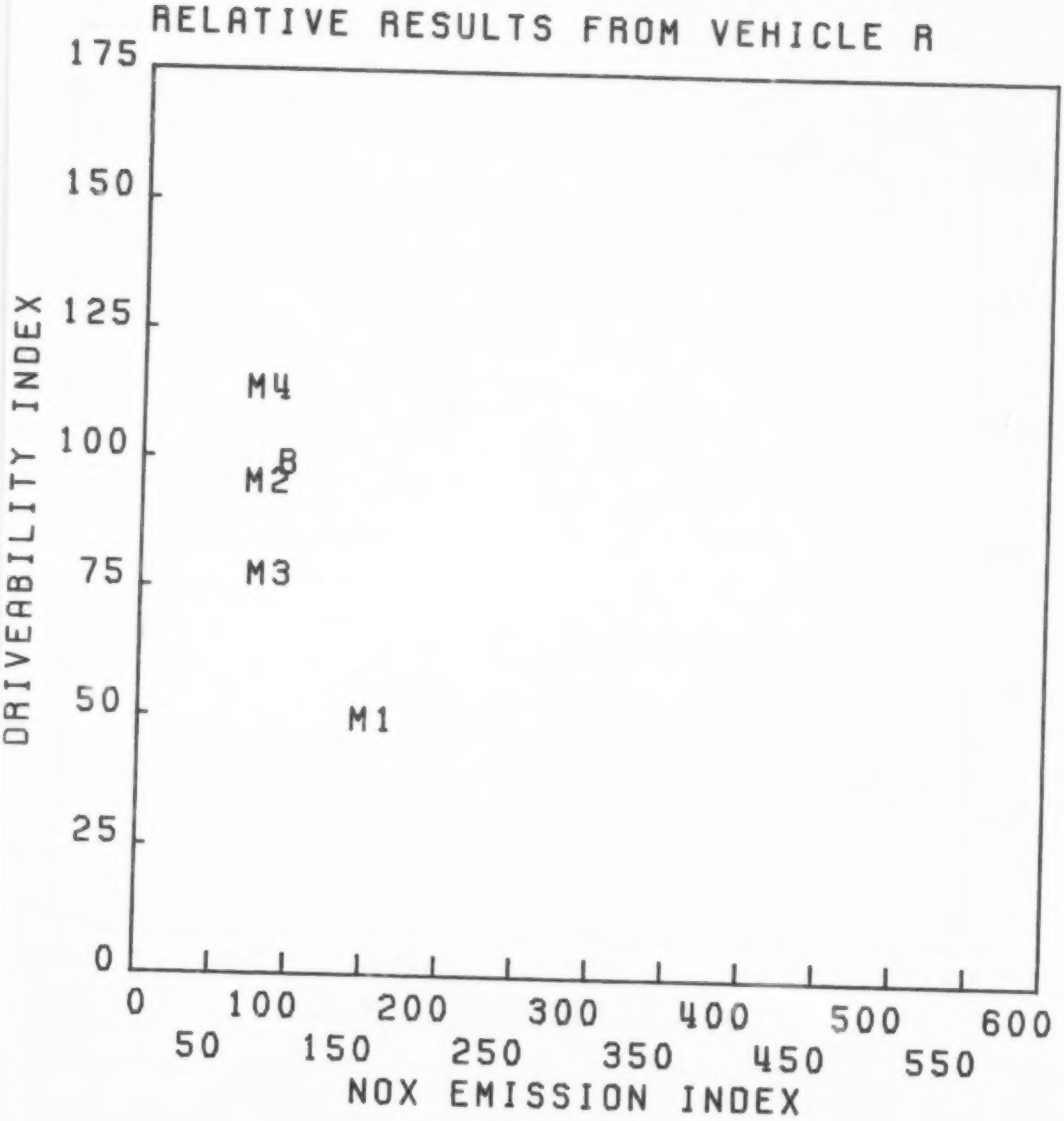

RELATIVE RESULTS FROM VEHICLE A
DRIVEABILITY INDEX
ACCELERATION INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
M4
M2
B
M3
M1


RELATIVE RESULTS FROM VEHICLE A
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M4
B
M2
M3
M1
75
100
125
FTP FUEL CONSUMPTION INDEX

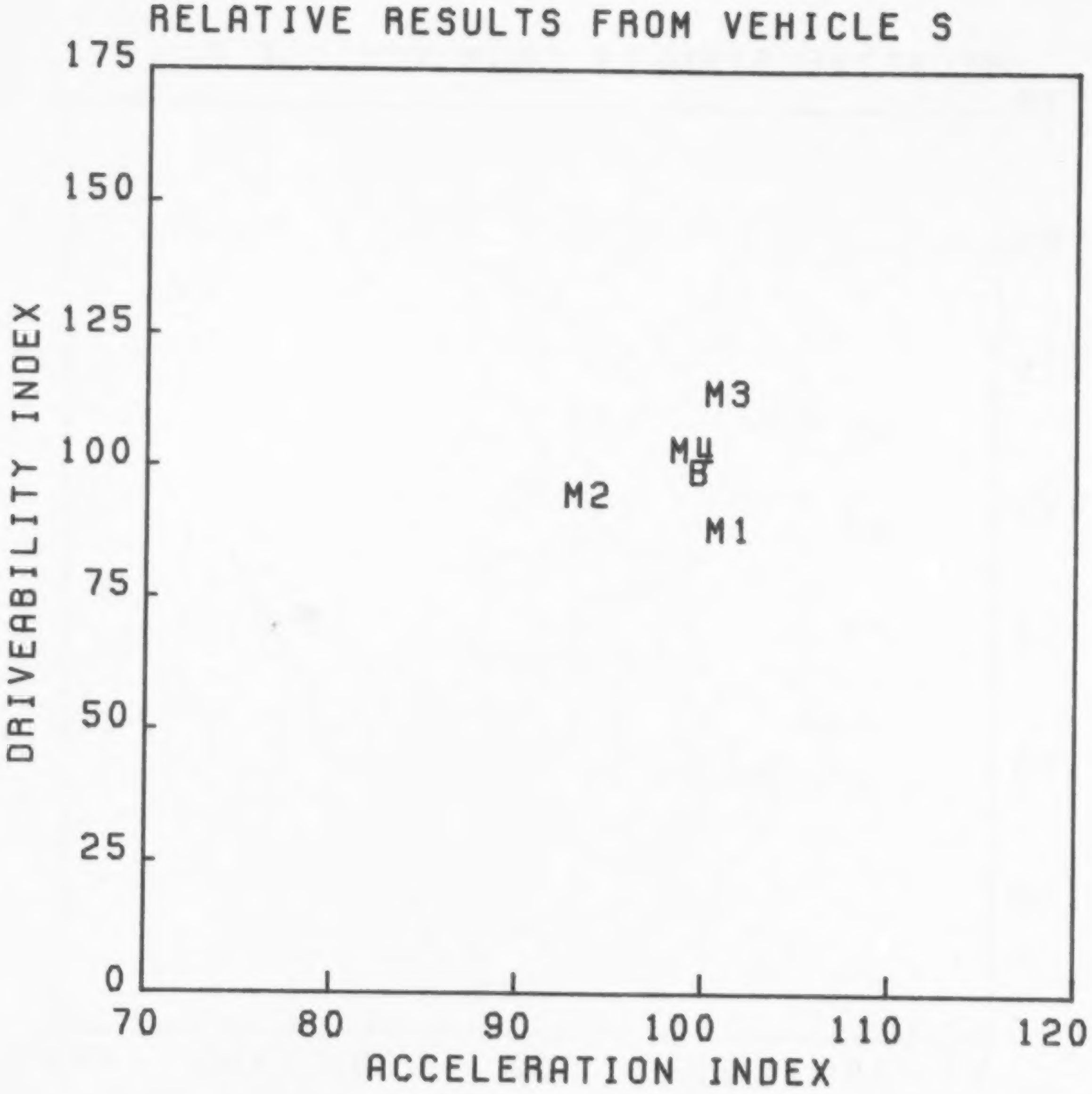

RELATIVE RESULTS FROM VEHICLE A
DRIVEABILITY INDEX
HFET FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
M4
B
M2
M3
M1

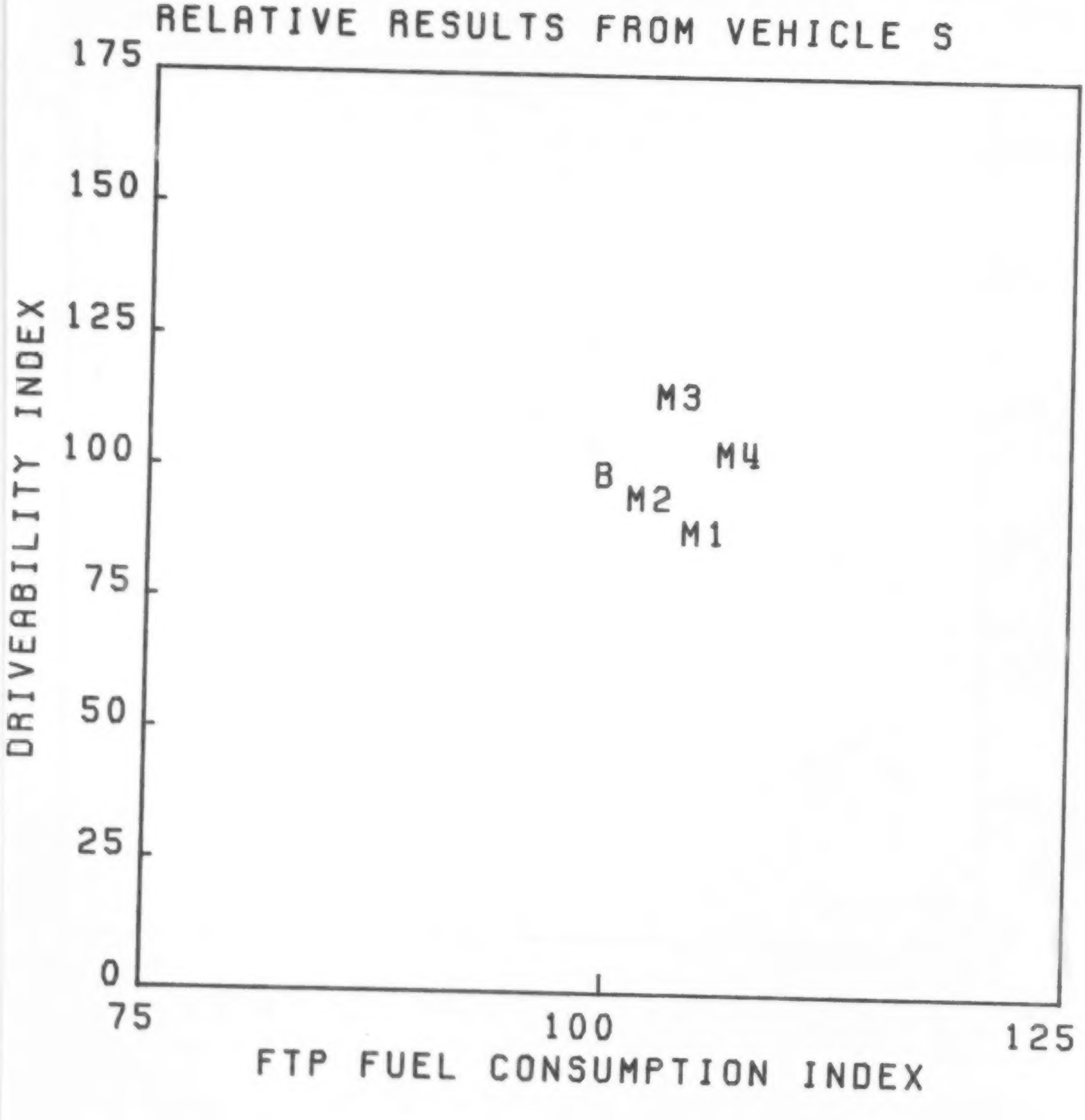

RELATIVE RESULTS FROM VEHICLE A
DRIVEABILITY INDEX
HC EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M4
M2
B
M3
M1

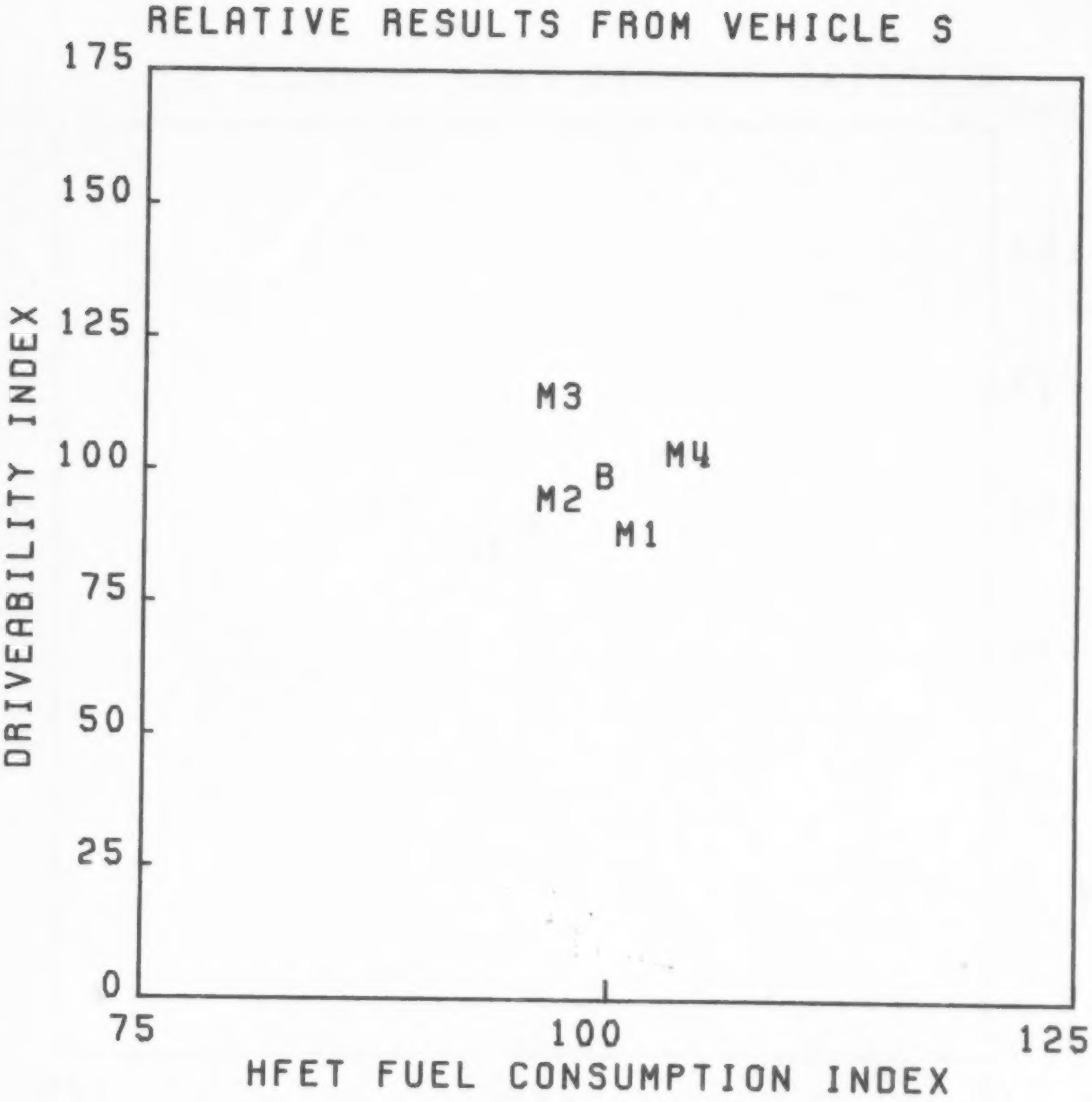

RELATIVE RESULTS FROM VEHICLE A
DRIVEABILITY INDEX
CO EMISSION INDEX
175
150
125
100
75
50
25
0
0
300
600
900
1200
1500
M4
B
M2
M3
M1

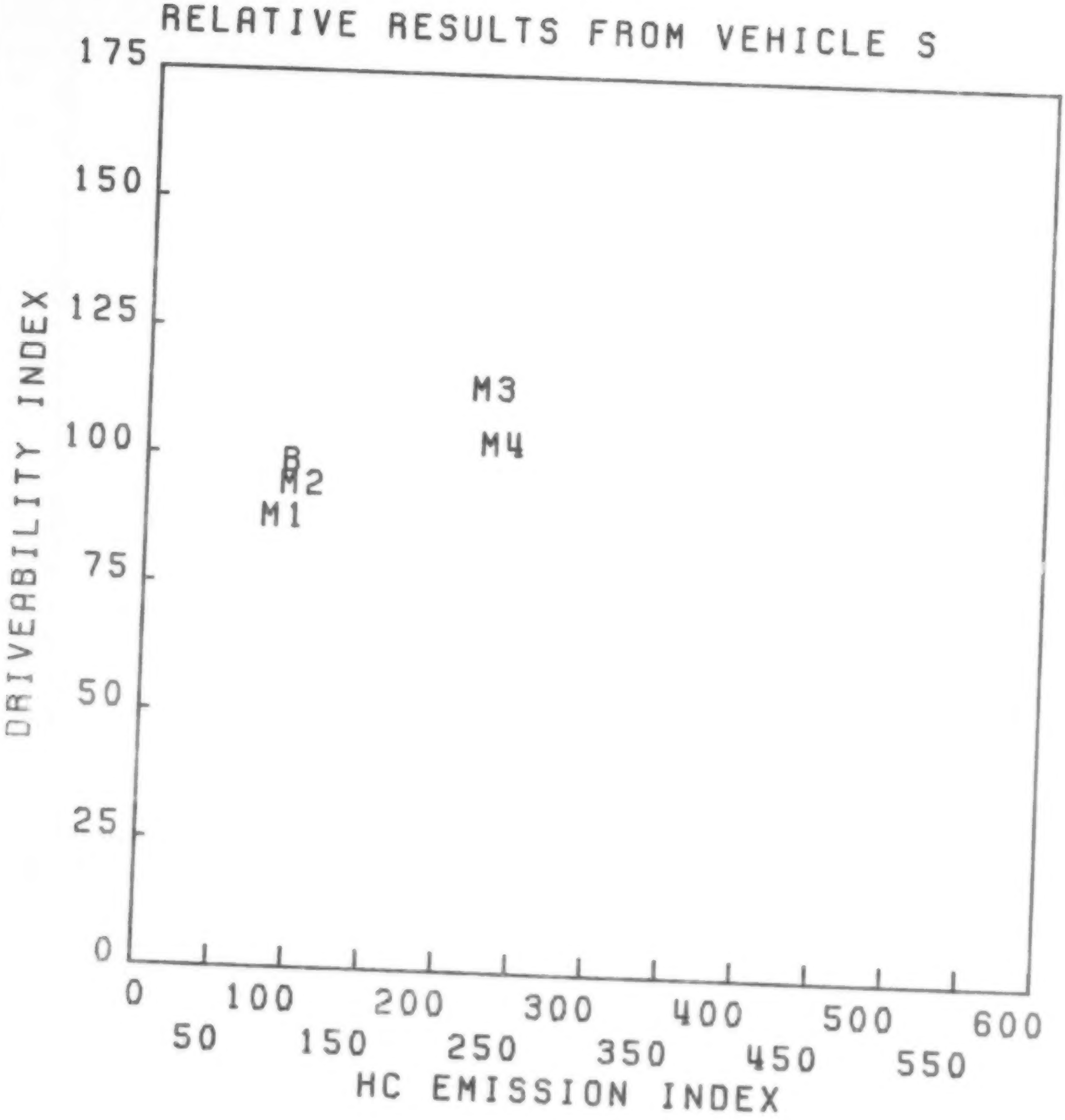


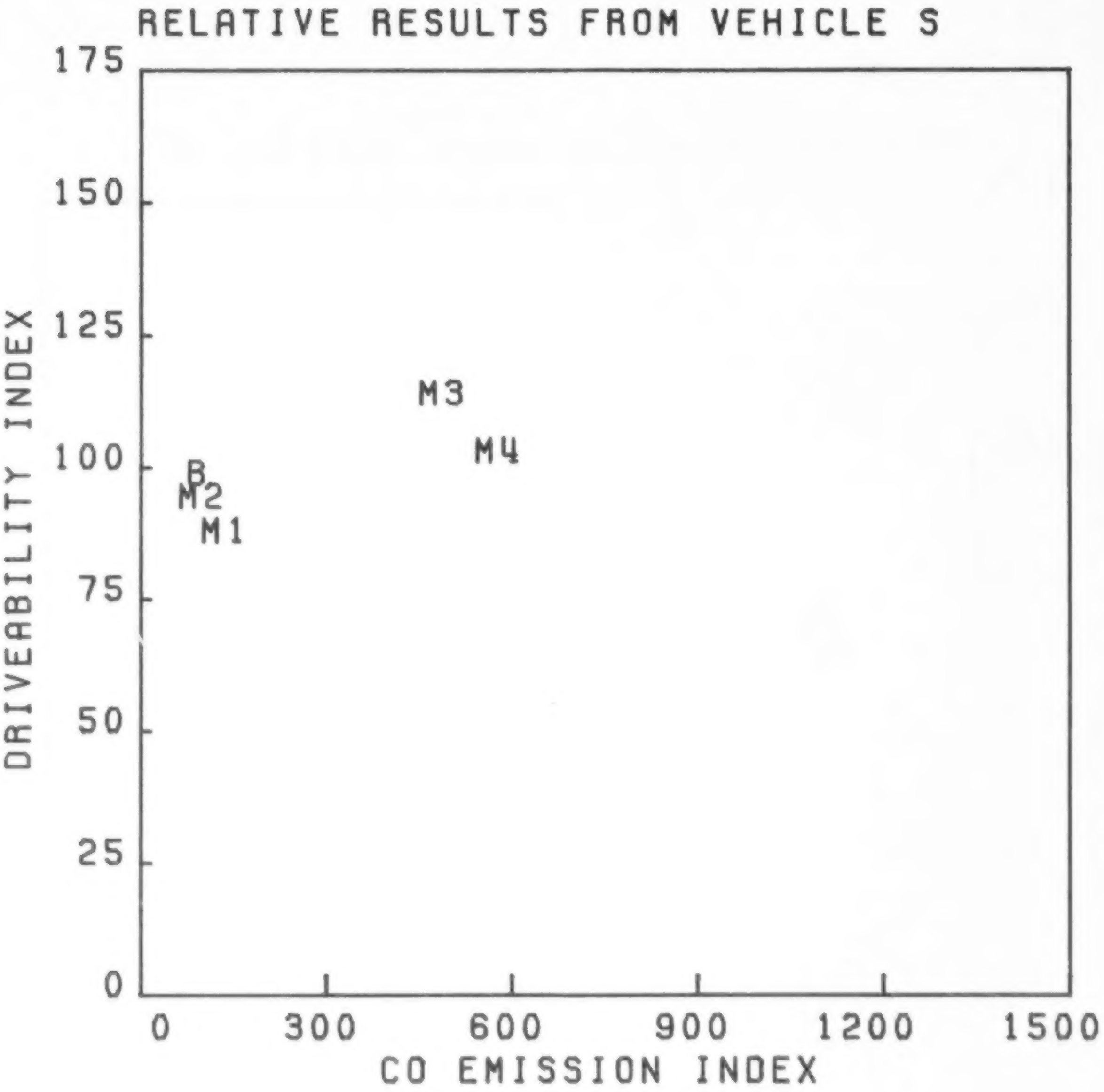
RELATIVE RESULTS FROM VEHICLE A

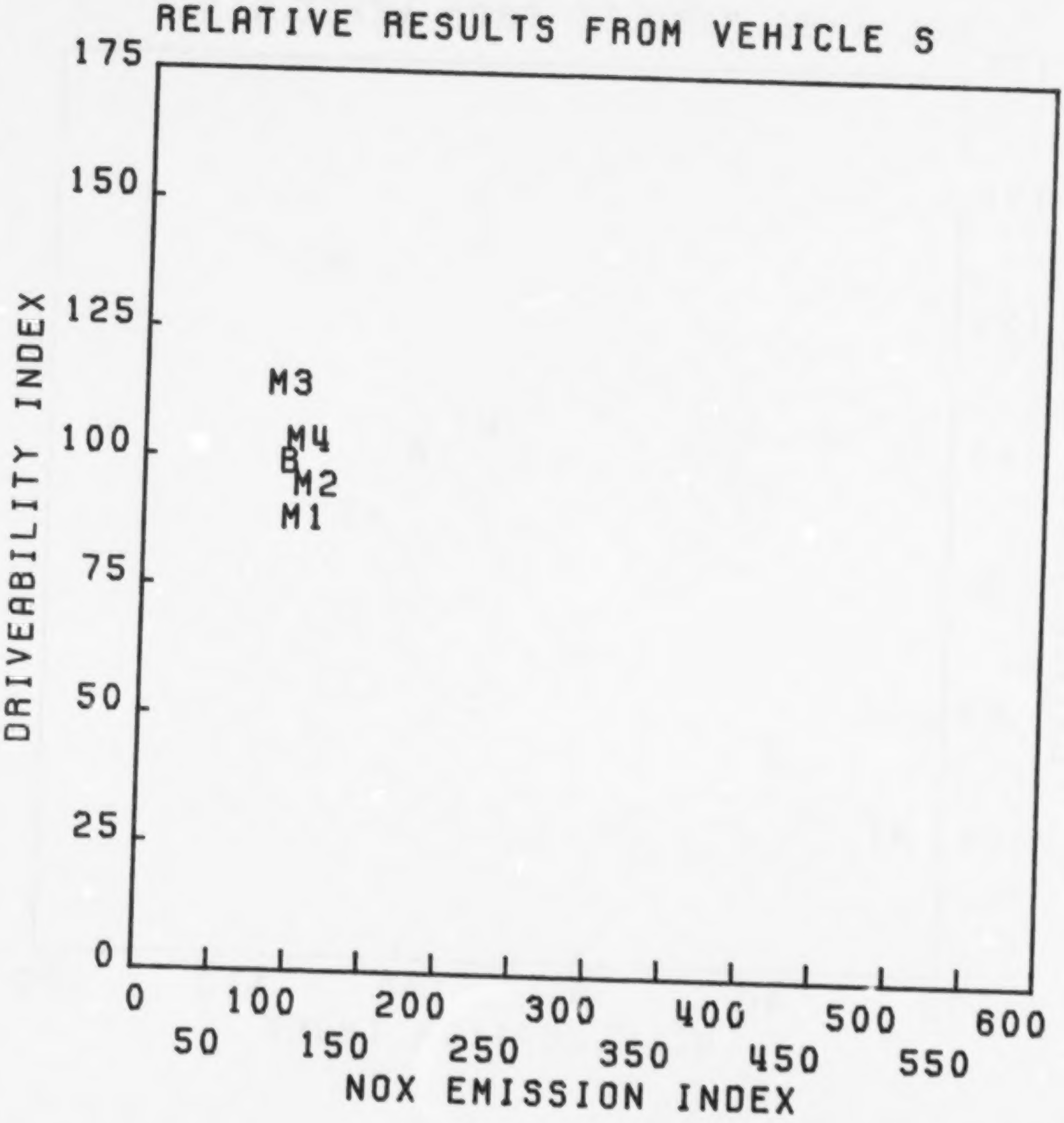

RELATIVE RESULTS FROM VEHICLE S
DRIVEABILITY INDEX
ACCELERATION INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
M3
M4
B
M2
M1

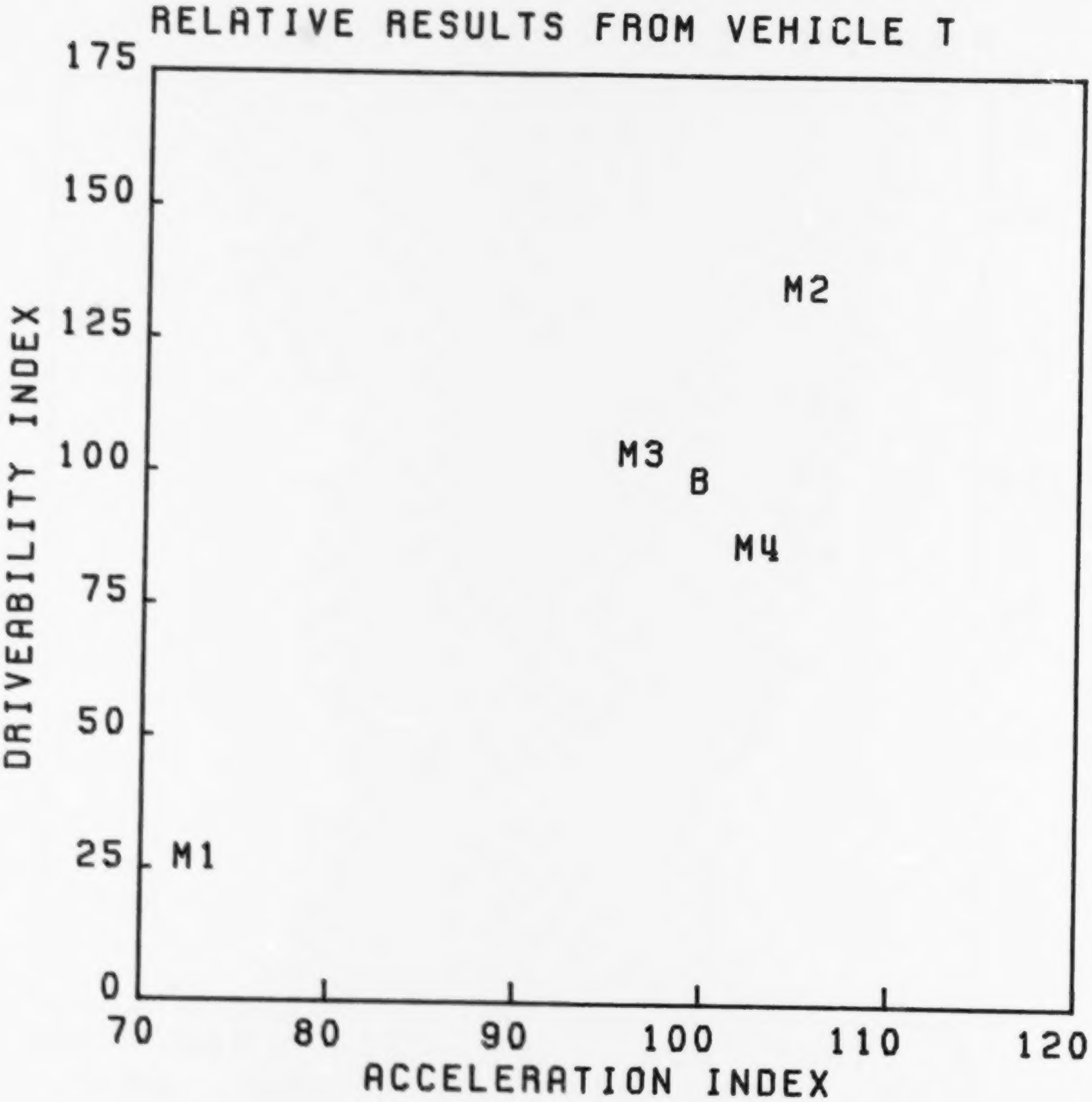

RELATIVE RESULTS FROM VEHICLE S
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M3
M4
B
M2
M1
75
100
125
FTP FUEL CONSUMPTION INDEX

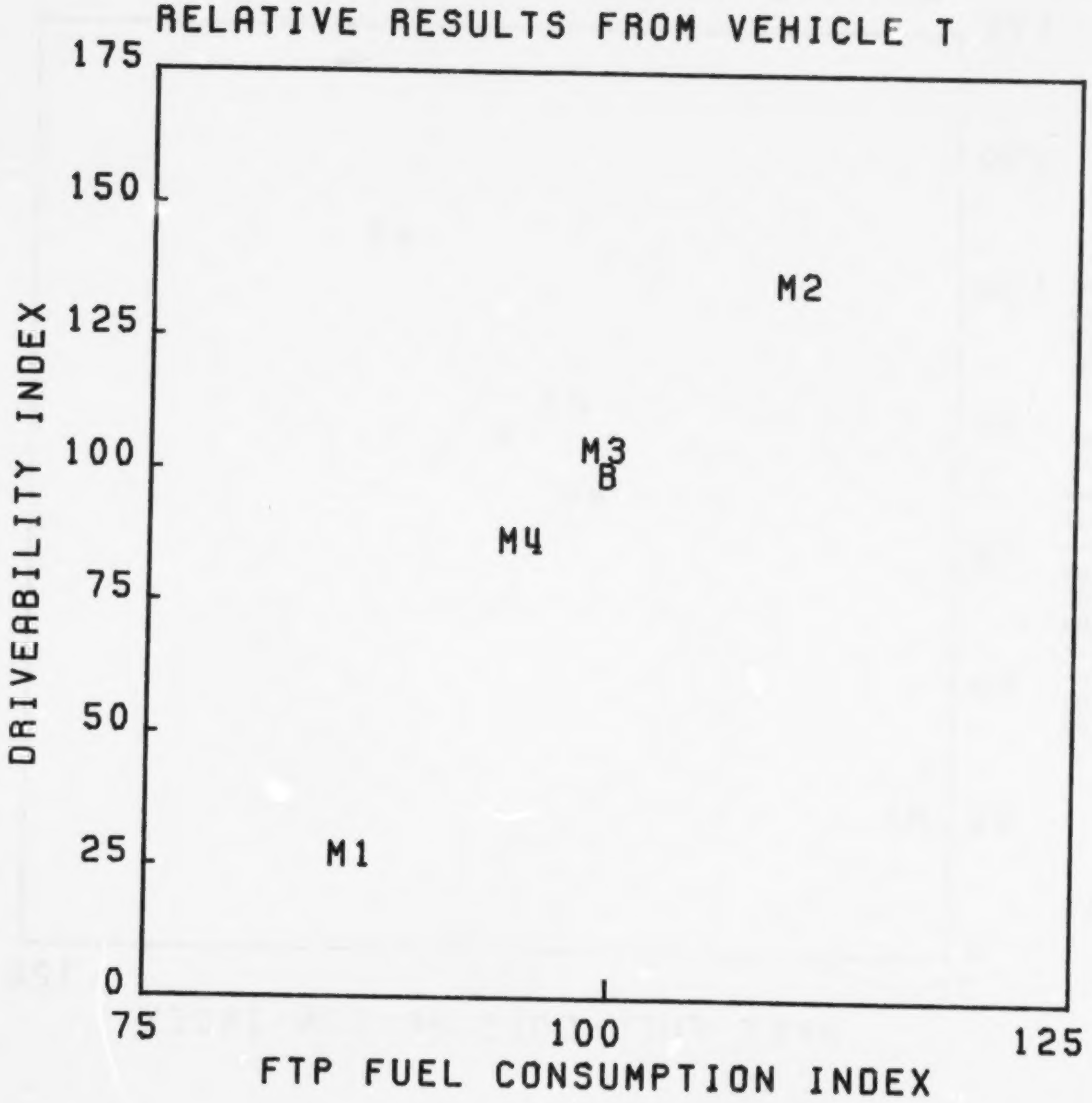

RELATIVE RESULTS FROM VEHICLE S
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M3
M4
B
M2
M1
75
100
125
HFET FUEL CONSUMPTION INDEX

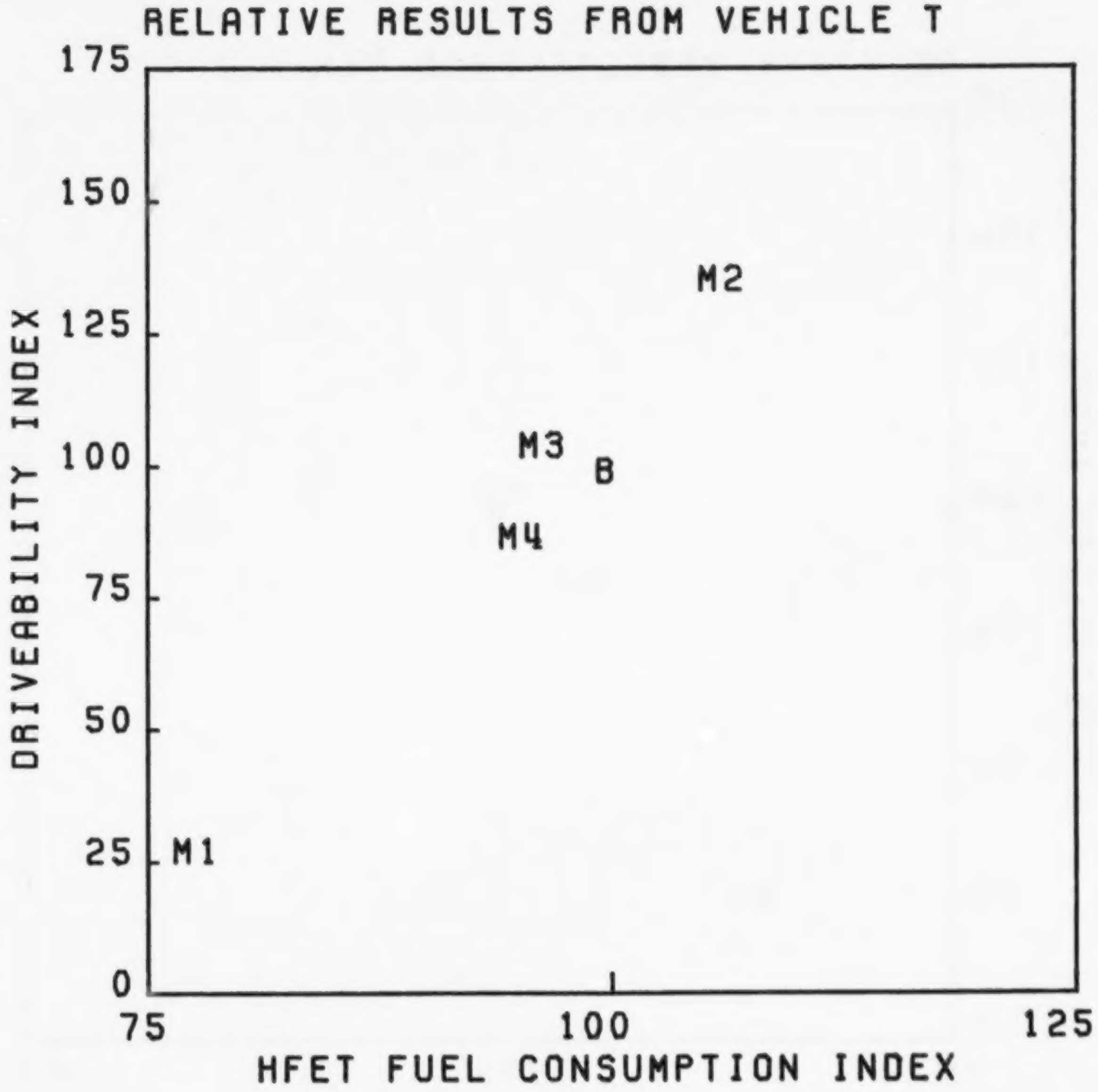

RELATIVE RESULTS FROM VEHICLE S
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
HC EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
B
M1
M2
M3
M4

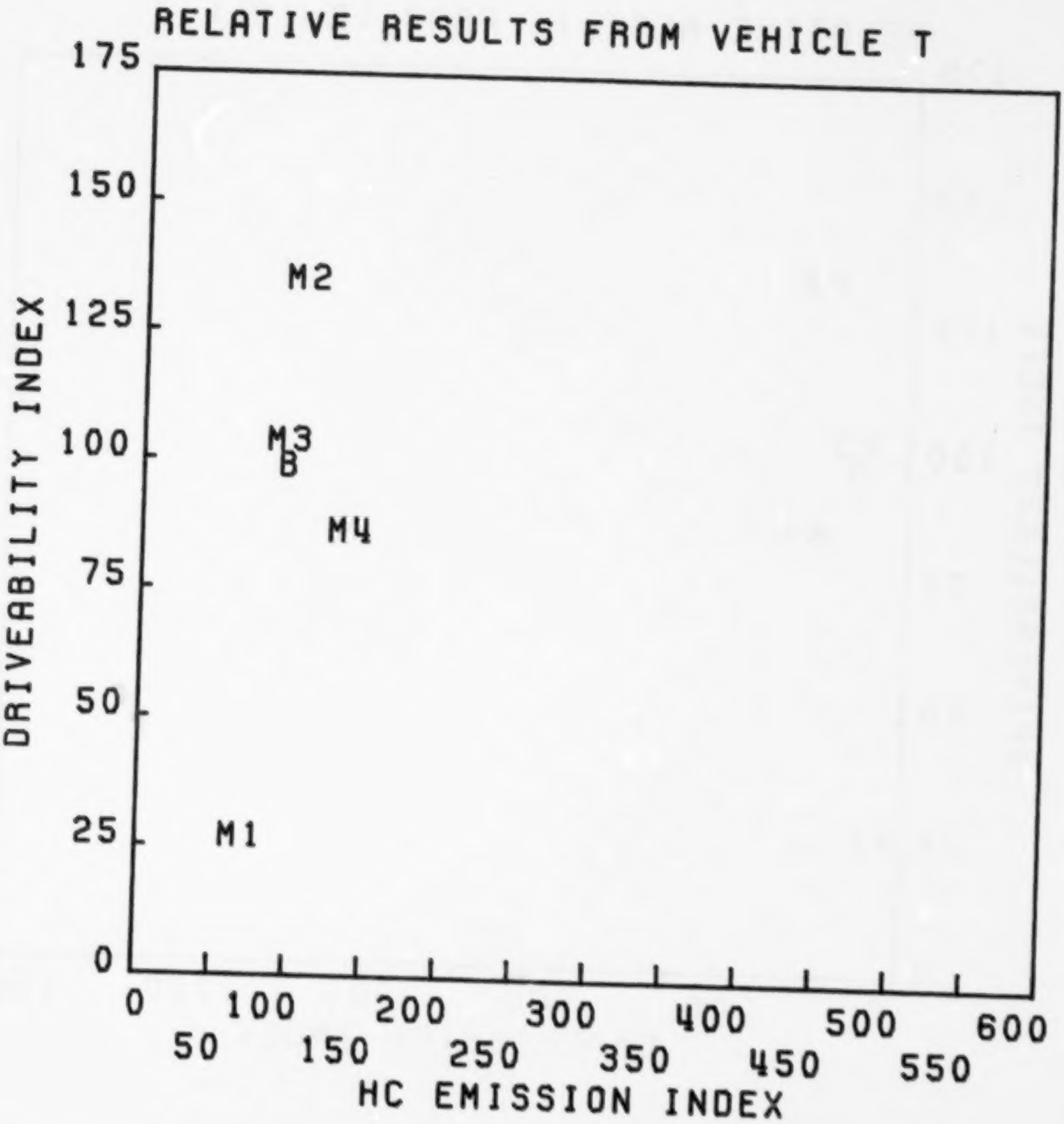

RELATIVE RESULTS FROM VEHICLE S
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
CO EMISSION INDEX
0
300
600
900
1200
1500
B
M2
M1
M3
M4

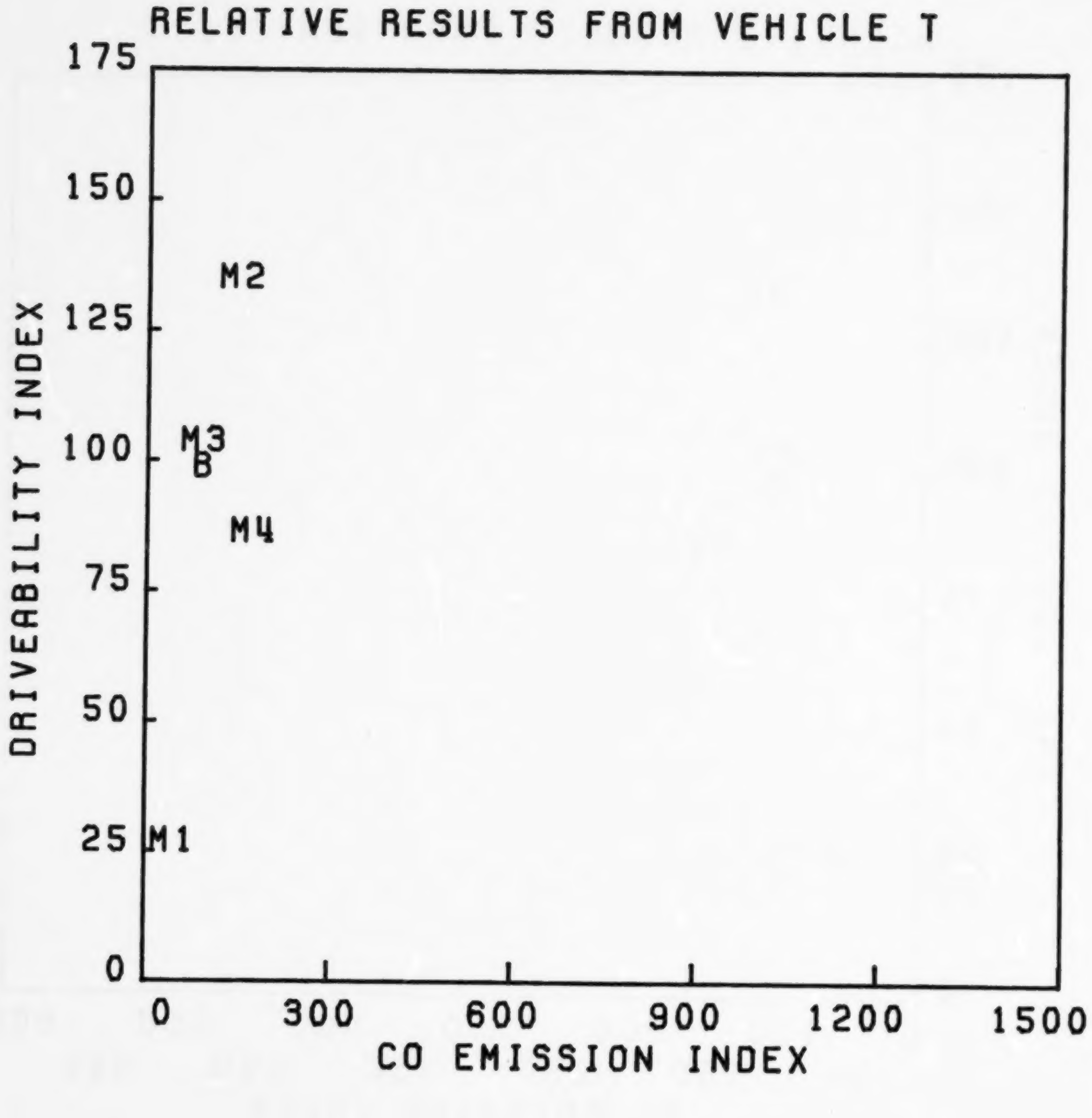

RELATIVE RESULTS FROM VEHICLE S
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
M4
B
M2
M1
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX

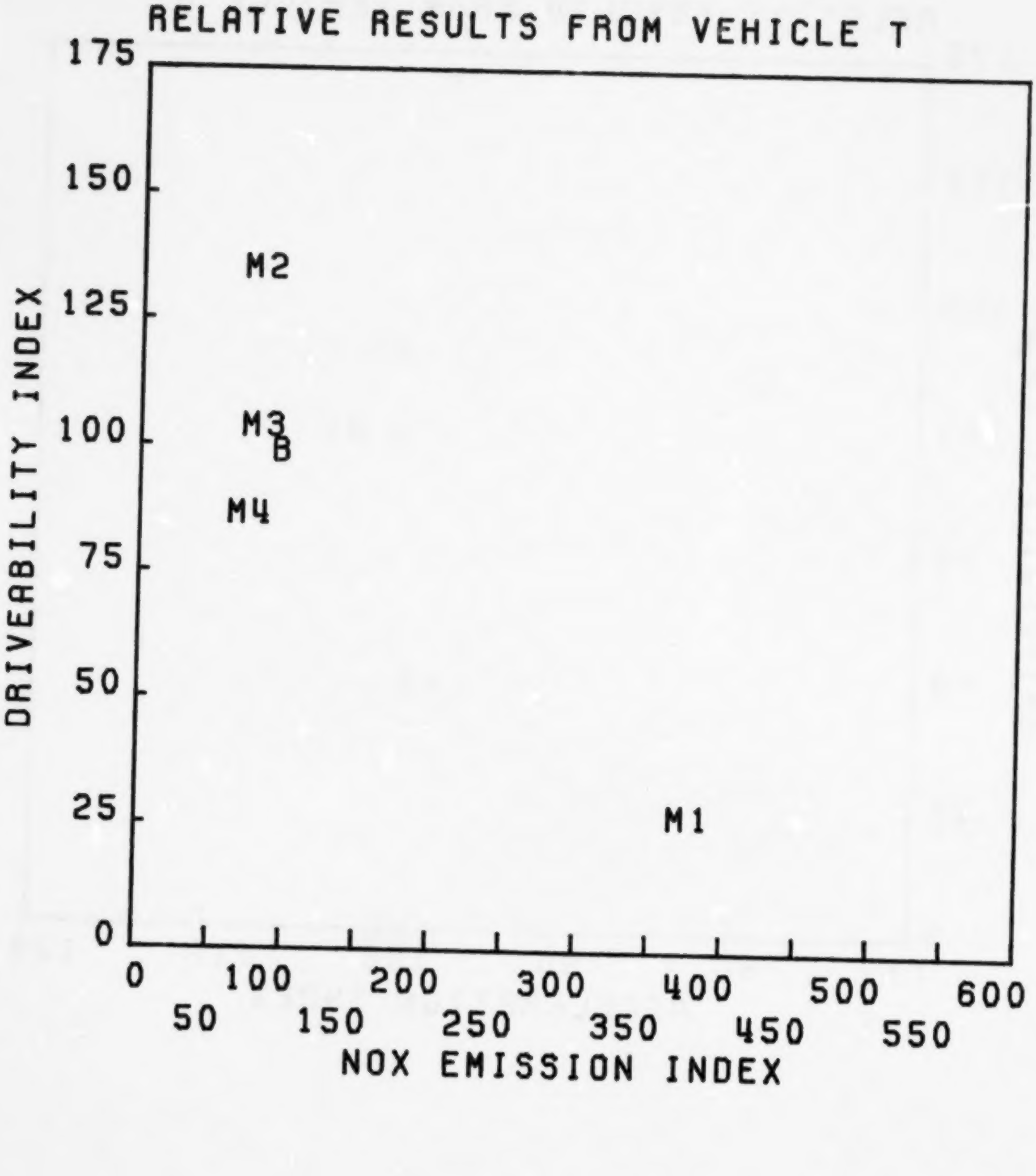

RELATIVE RESULTS FROM VEHICLE T
DRIVEABILITY INDEX
ACCELERATION INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
M2
M3
B
M4
M1

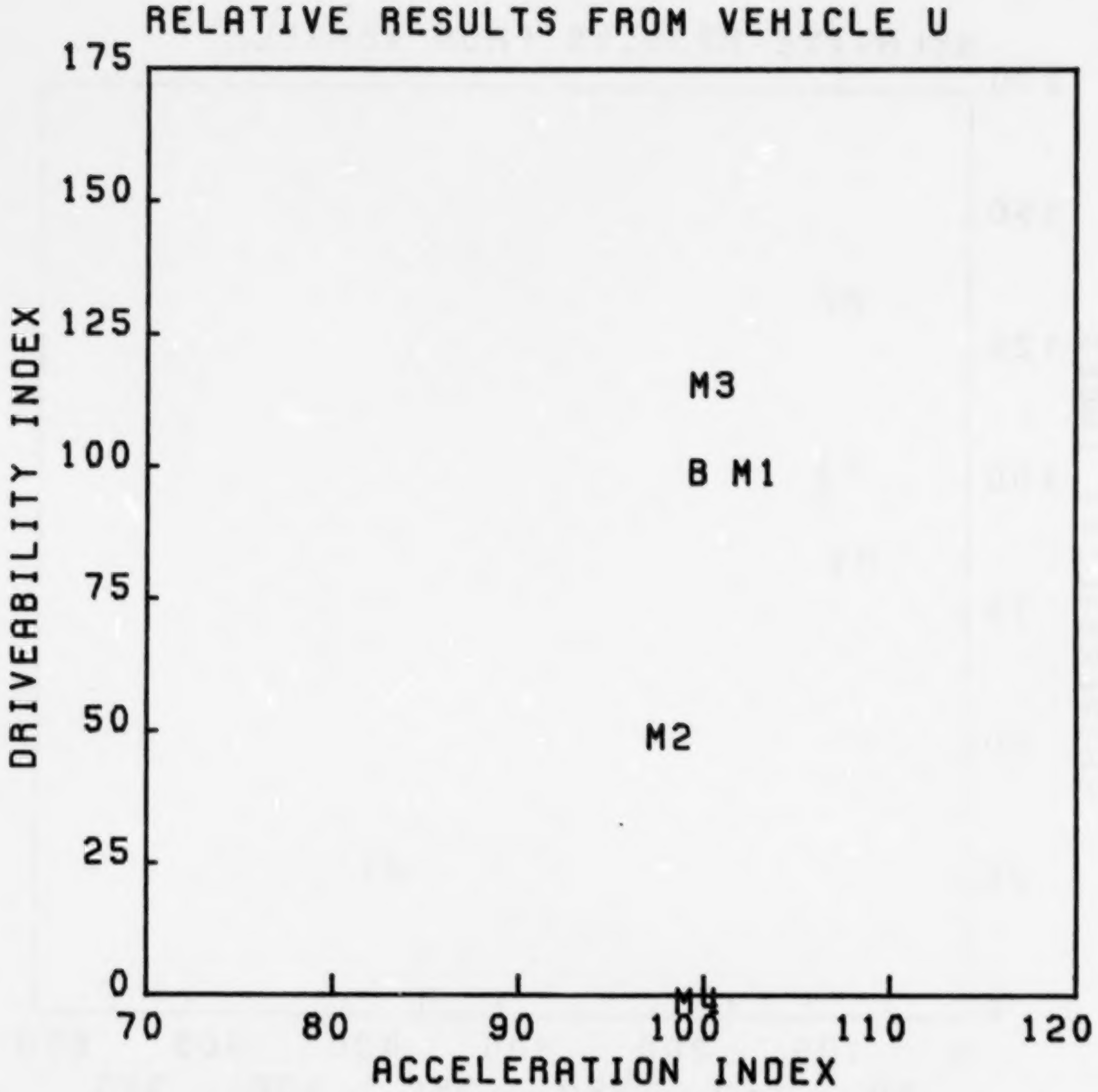

RELATIVE RESULTS FROM VEHICLE T
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M2
M3
B
M4
M1
75
100
125
FTP FUEL CONSUMPTION INDEX

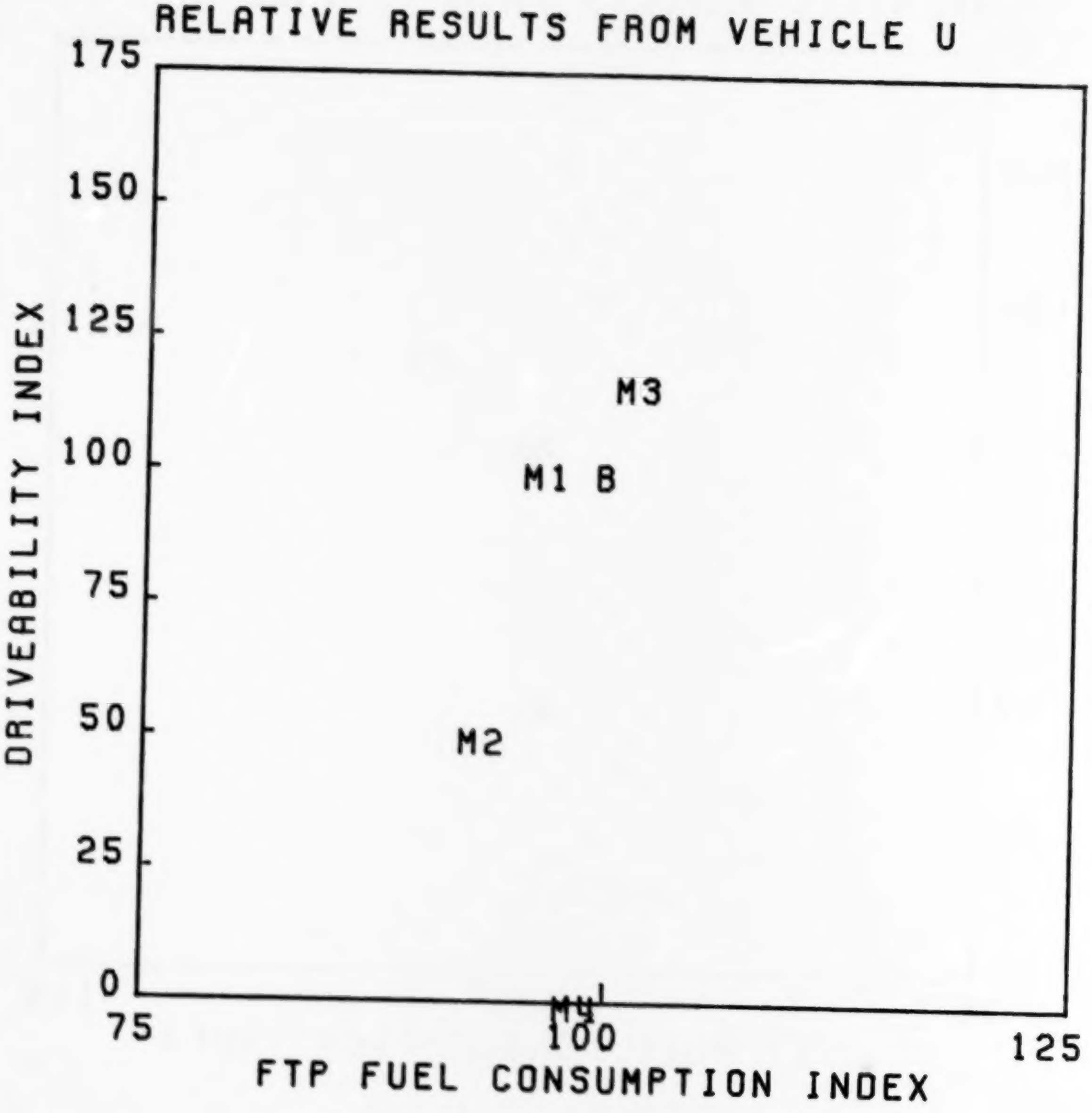

RELATIVE RESULTS FROM VEHICLE T
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
HFET FUEL CONSUMPTION INDEX
M2
M3
B
M4
M1

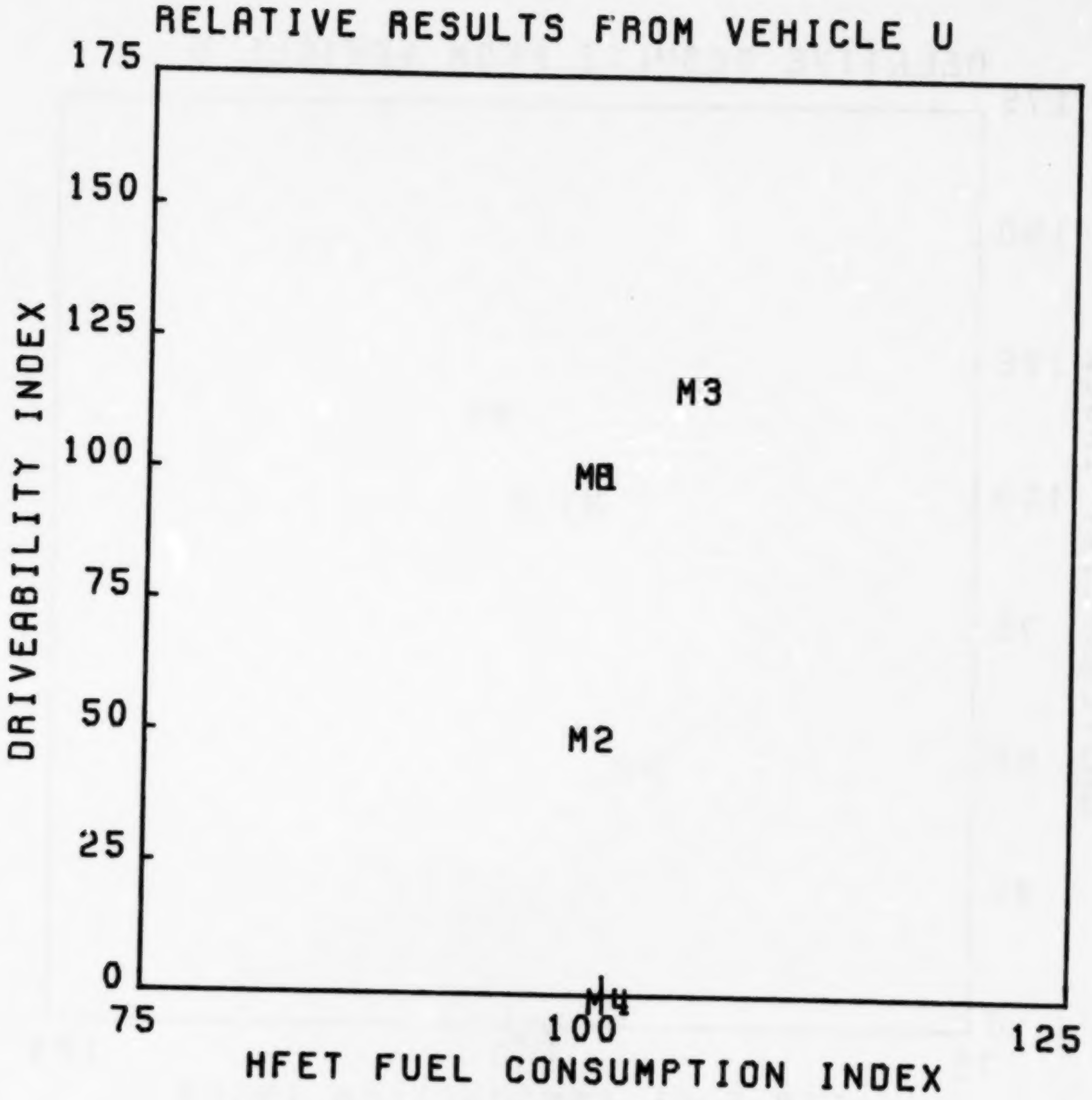

RELATIVE RESULTS FROM VEHICLE T
DRIVEABILITY INDEX
HC EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M2
M3
B
M4
M1

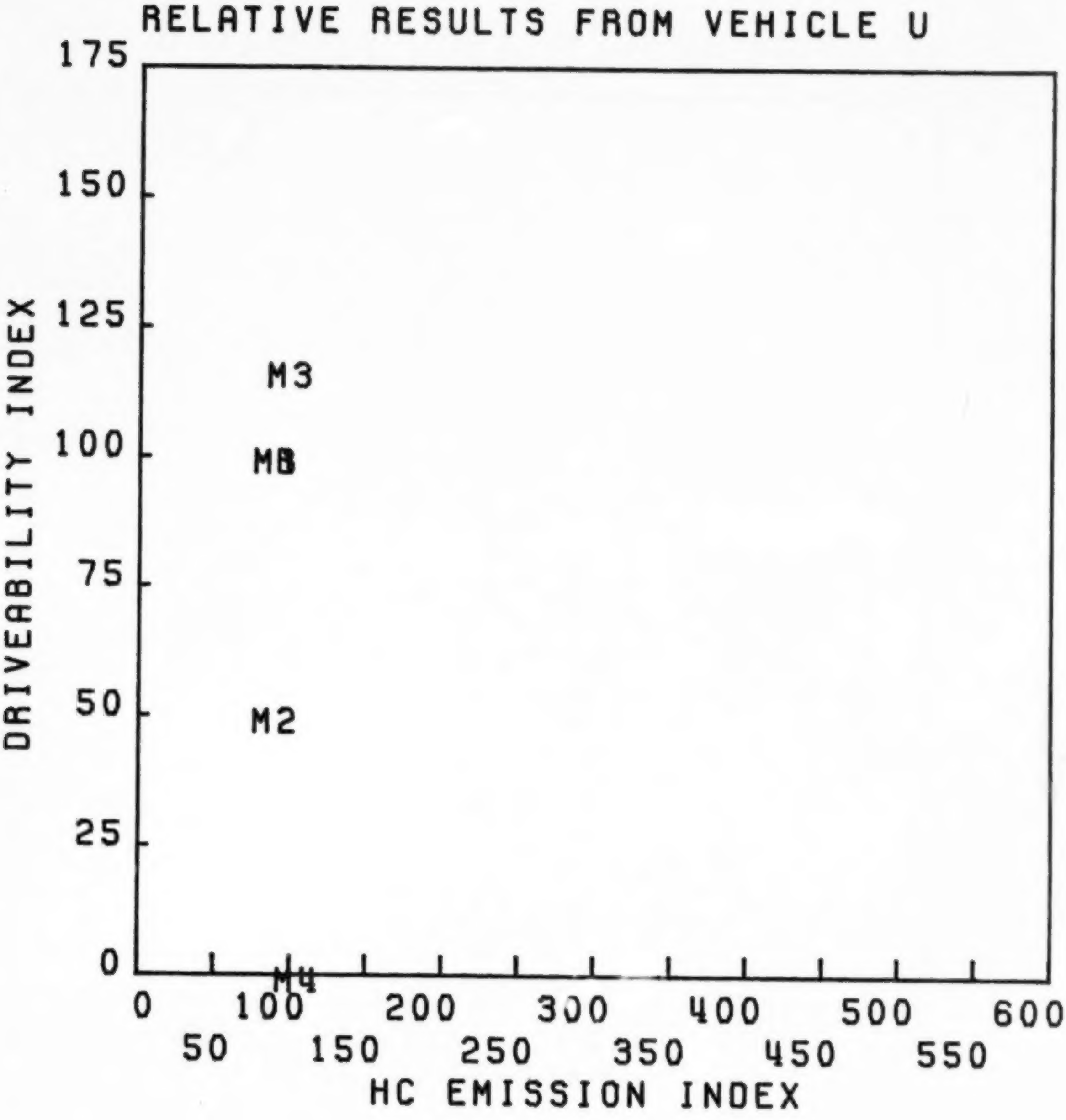

RELATIVE RESULTS FROM VEHICLE T
DRIVEABILITY INDEX
CO EMISSION INDEX
175
150
125
100
75
50
25
0
0
300
600
900
1200
1500
M1
M2
M3
B
M4

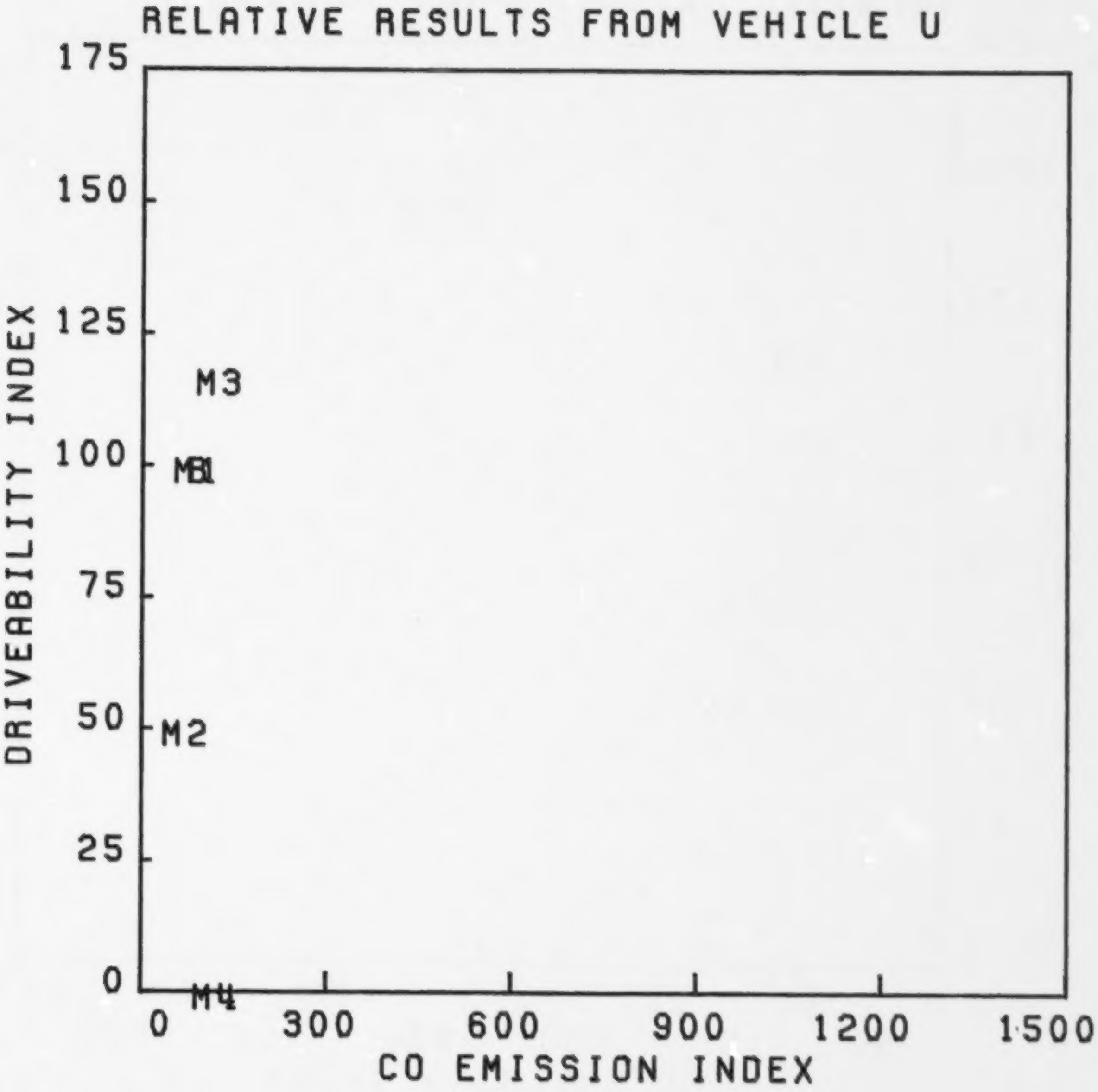

RELATIVE RESULTS FROM VEHICLE T
DRIVEABILITY INDEX
NOX EMISSION INDEX
0
25
50
75
100
125
150
175
0
50
100
150
200
250
300
350
400
450
500
550
600
M2
M3
B
M4
M1

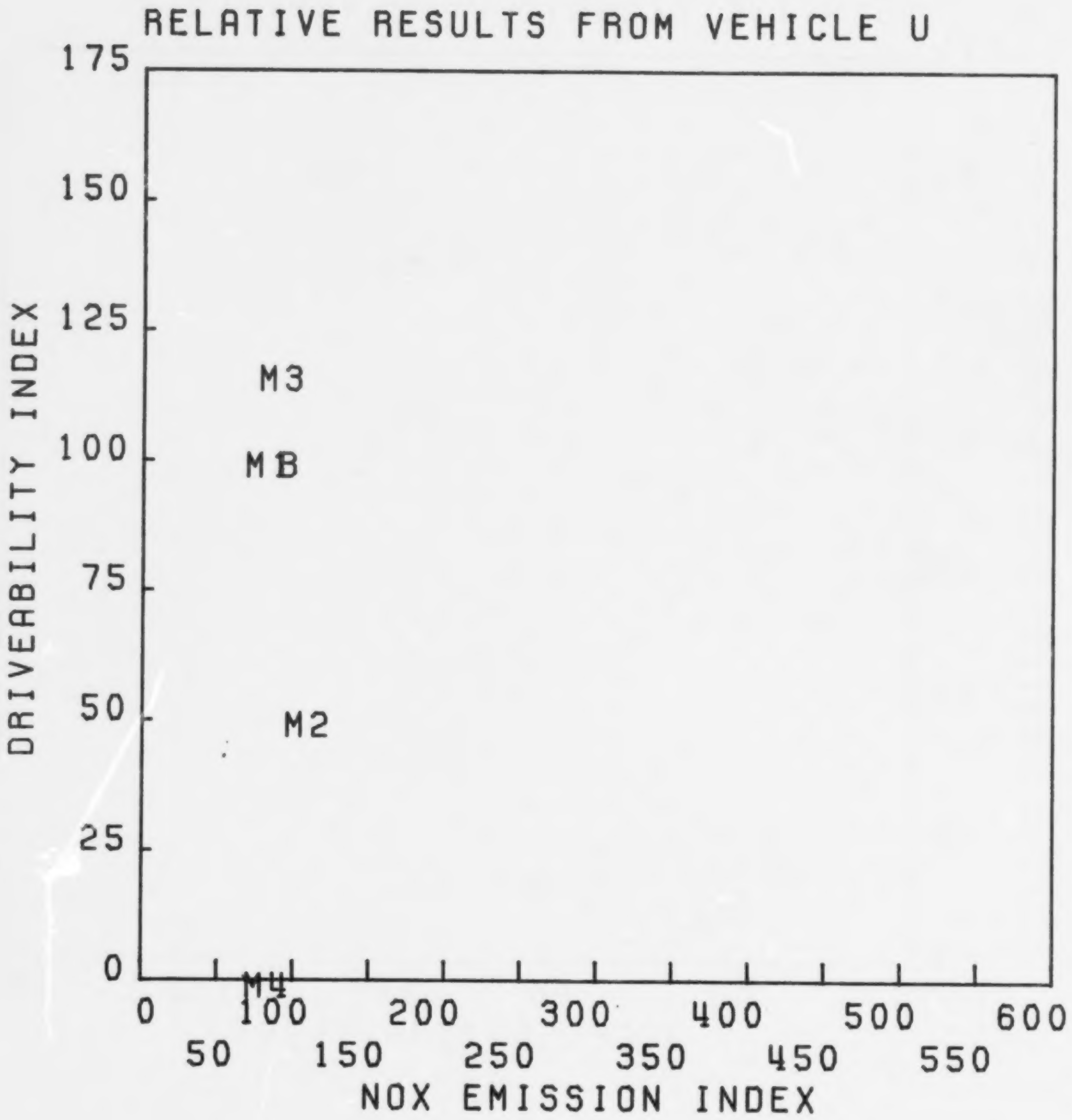

RELATIVE RESULTS FROM VEHICLE U
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
B M1
M2
M4
70
80
90
100
110
120
ACCELERATION INDEX

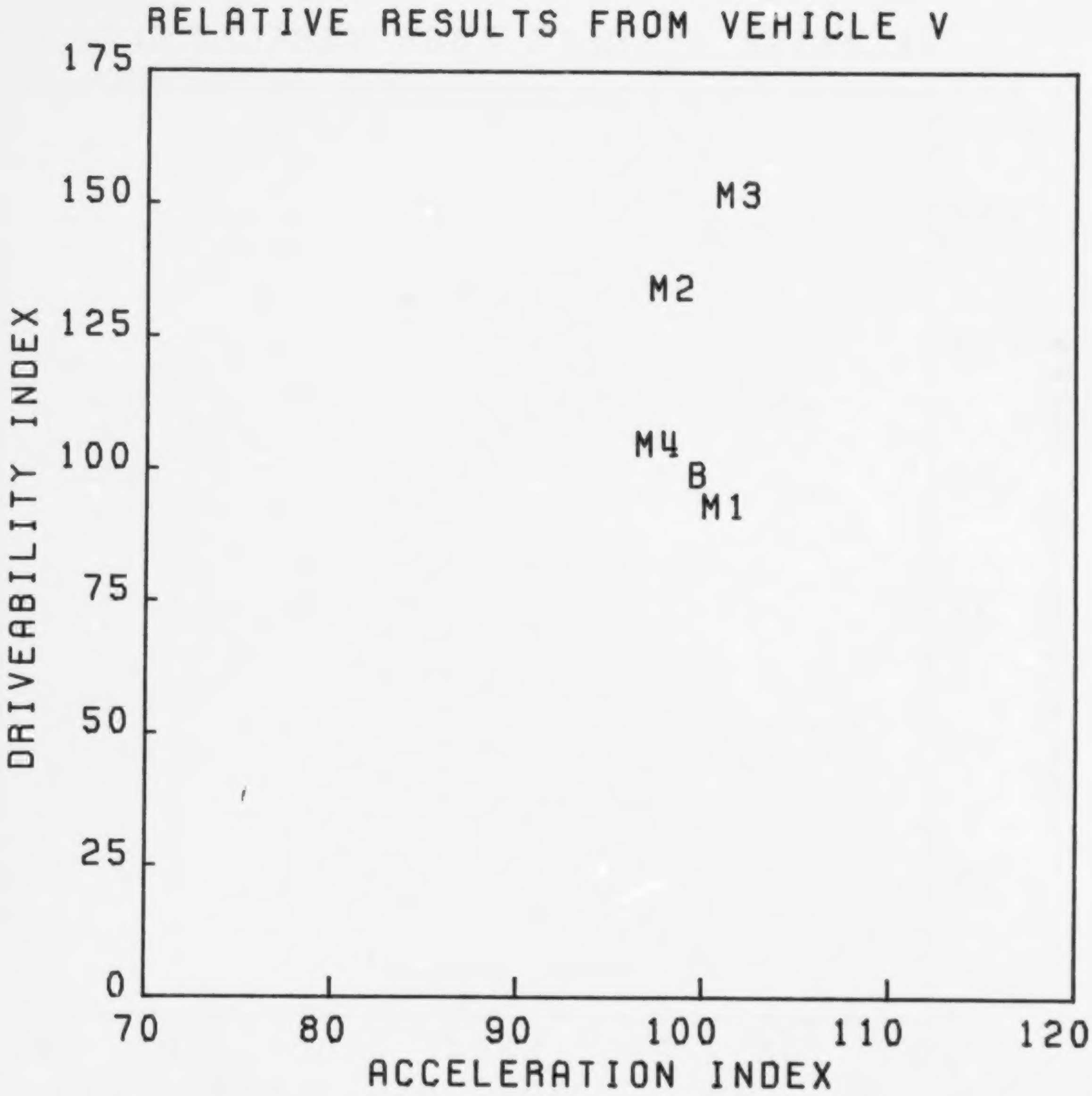

RELATIVE RESULTS FROM VEHICLE U
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
FTP FUEL CONSUMPTION INDEX
75
100
125
M3
M1
B
M2
M4

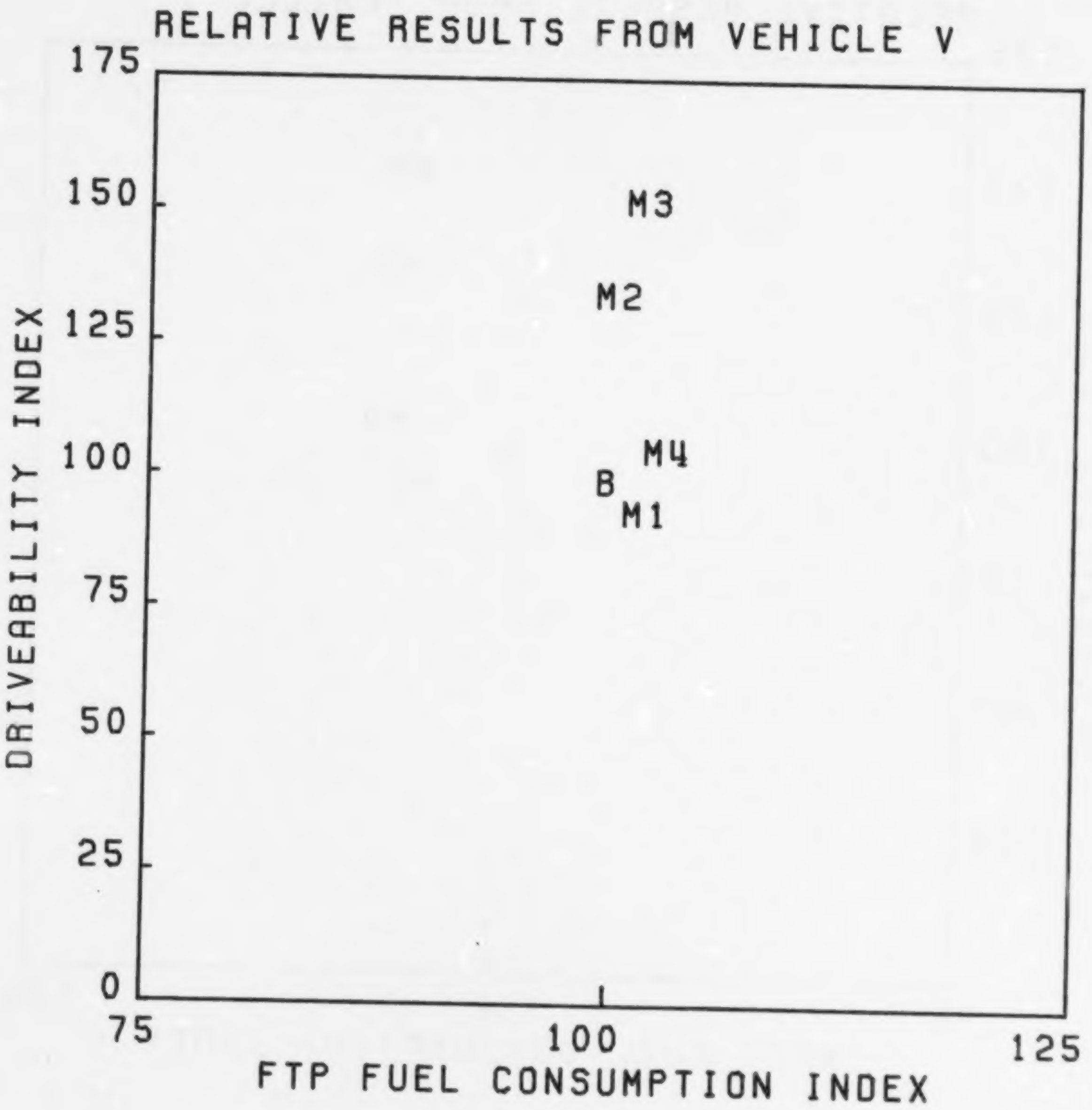

RELATIVE RESULTS FROM VEHICLE U
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M3
MB
M2
M4
75
100
125
HFET FUEL CONSUMPTION INDEX

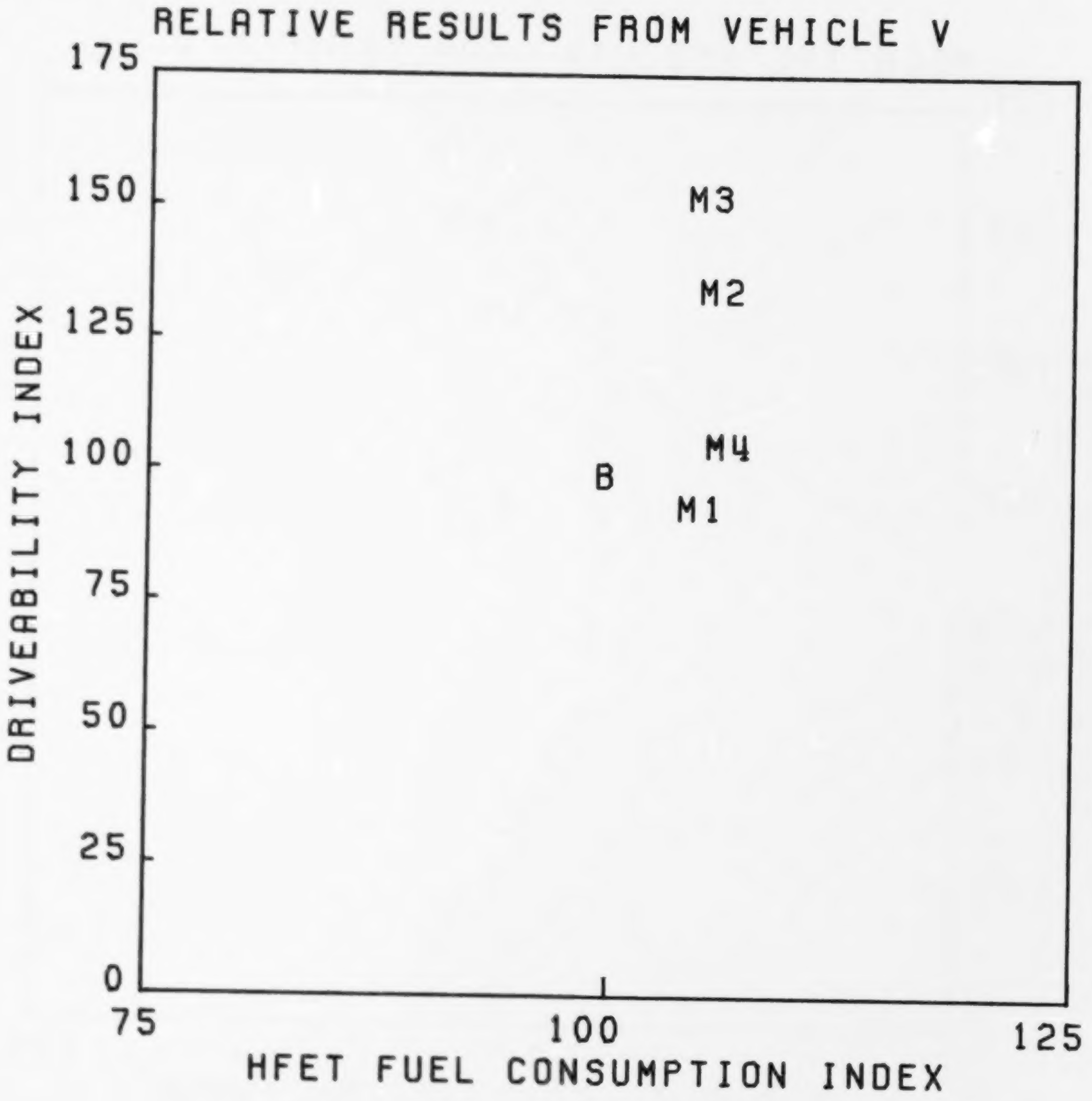

RELATIVE RESULTS FROM VEHICLE U
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
MB
M2
M4
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX

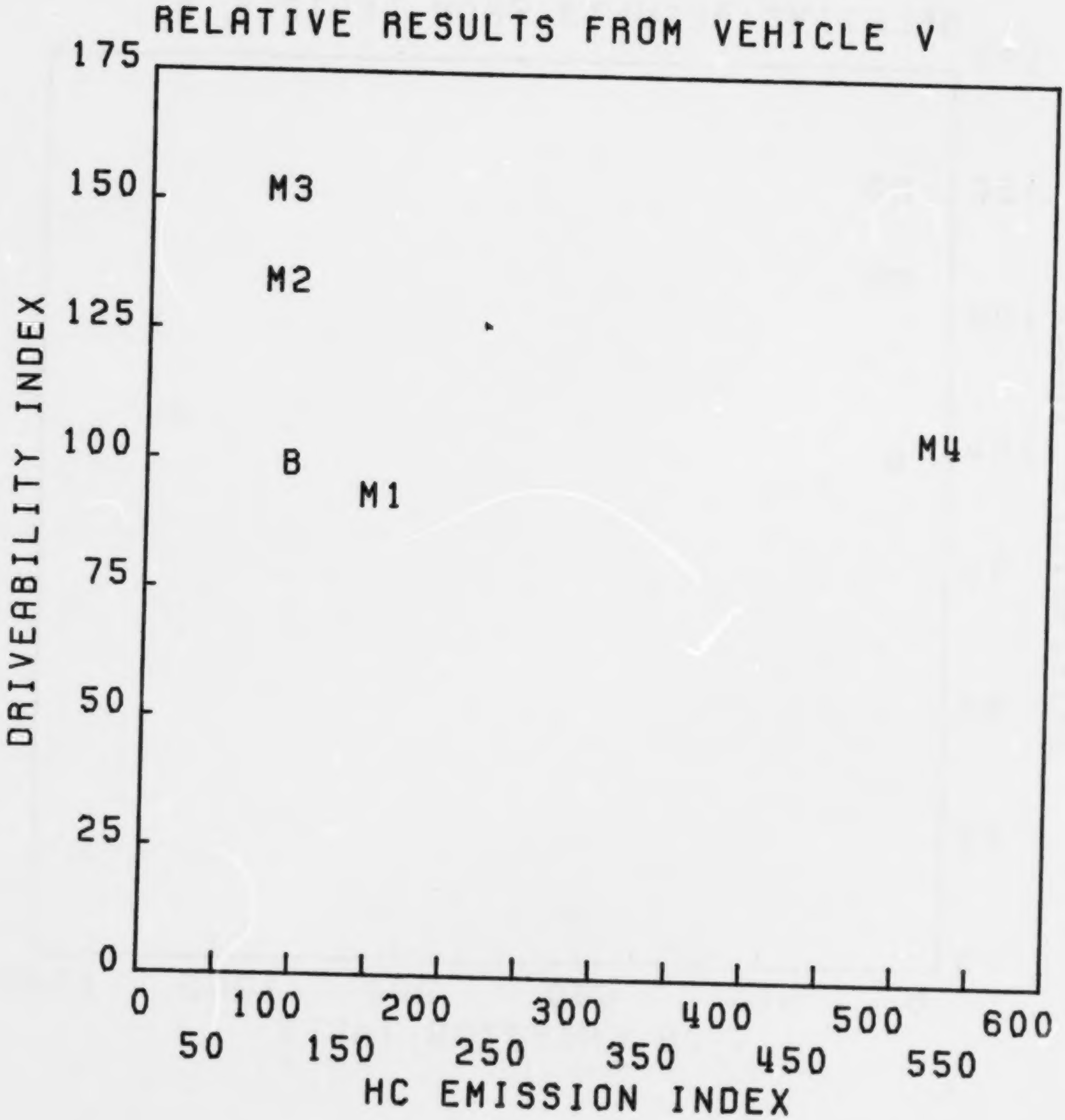

RELATIVE RESULTS FROM VEHICLE U
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
MB1
M2
M4
0
300
600
900
1200
1500
CO EMISSION INDEX

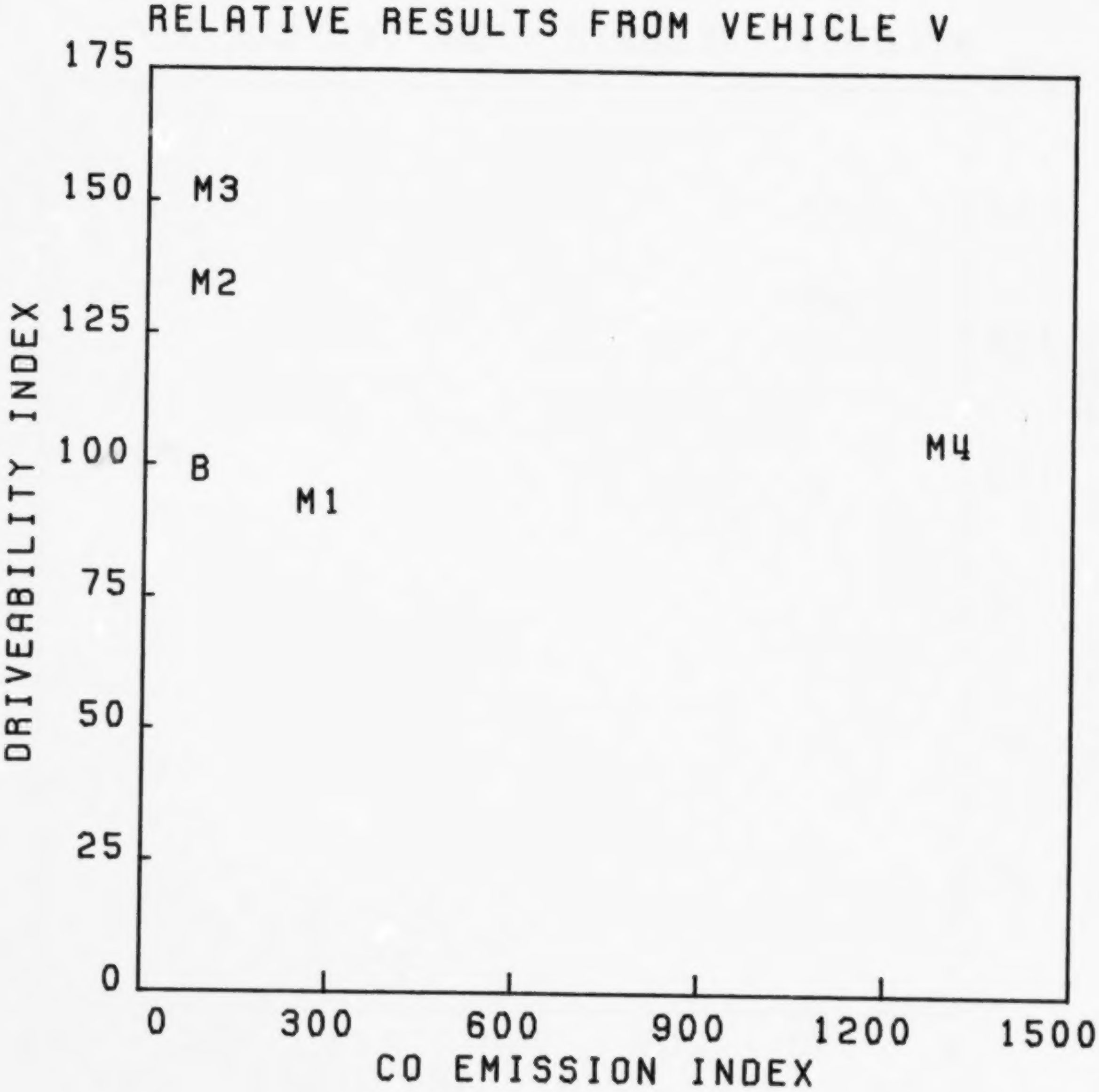

RELATIVE RESULTS FROM VEHICLE U
DRIVEABILITY INDEX
NOX EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M3
M B
M2
M4

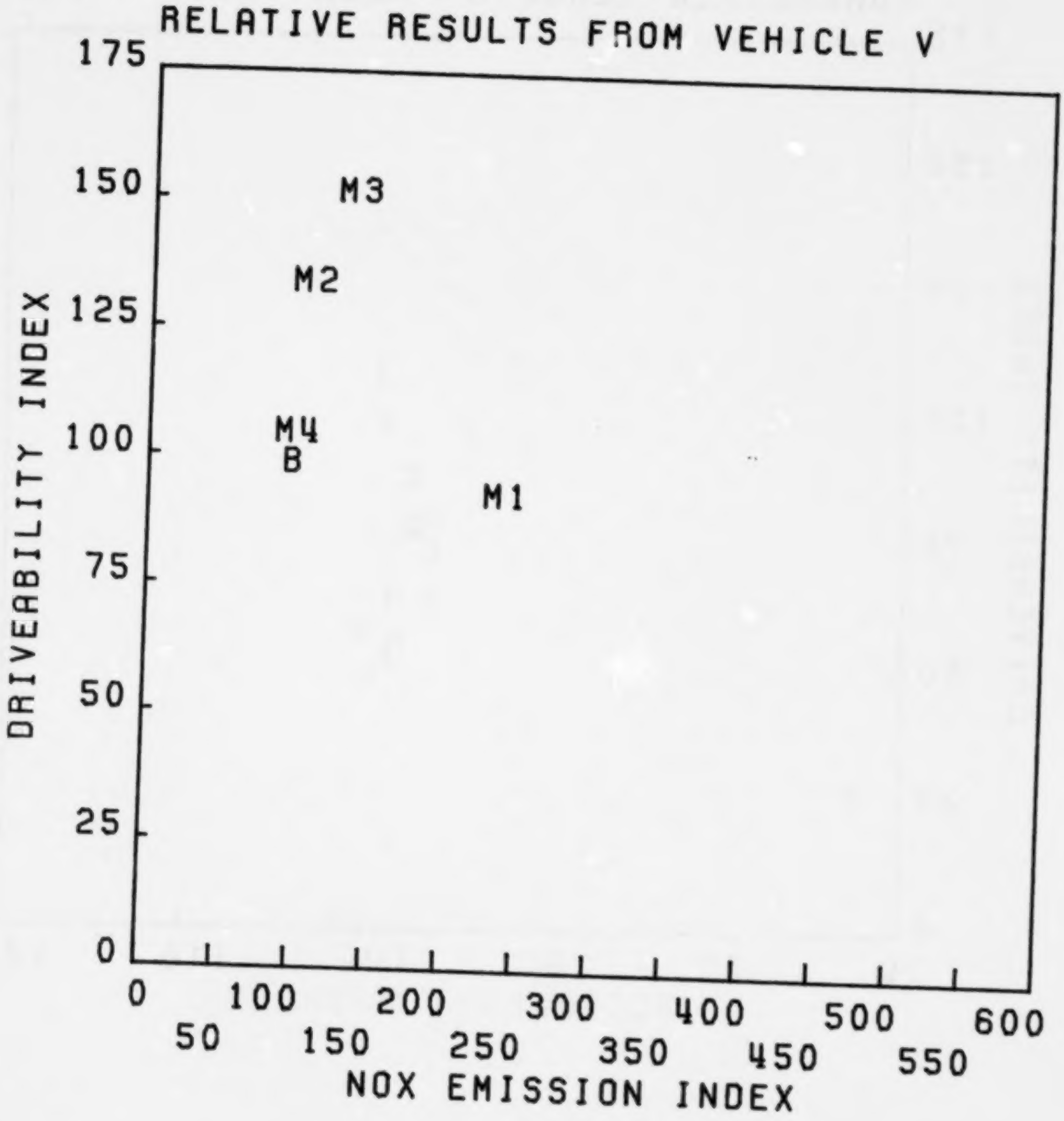

RELATIVE RESULTS FROM VEHICLE V
DRIVEABILITY INDEX
ACCELERATION INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
M3
M2
M4
B
M1

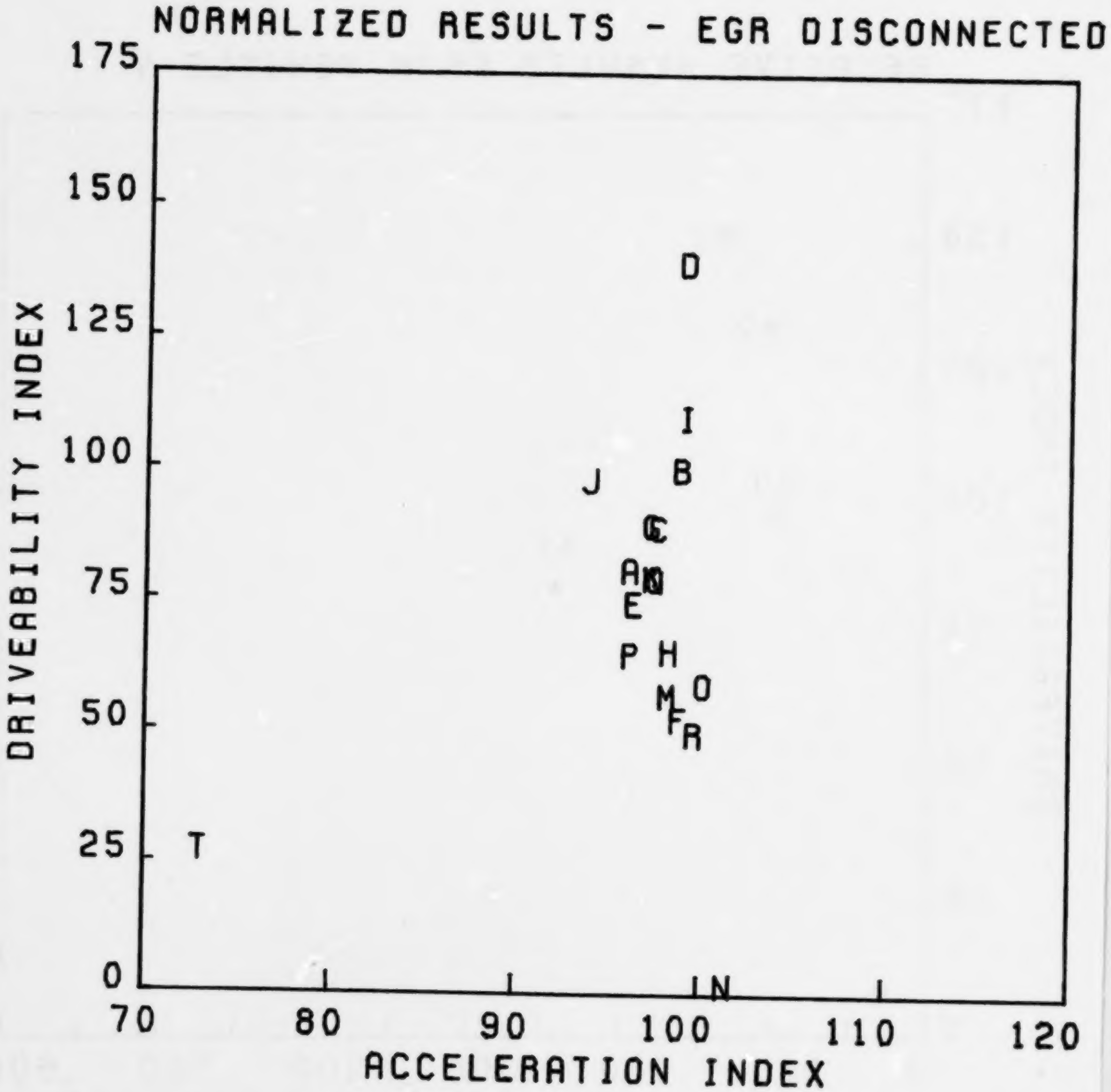

RELATIVE RESULTS FROM VEHICLE V
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M3
M2
M4
B
M1
75
100
125
FTP FUEL CONSUMPTION INDEX

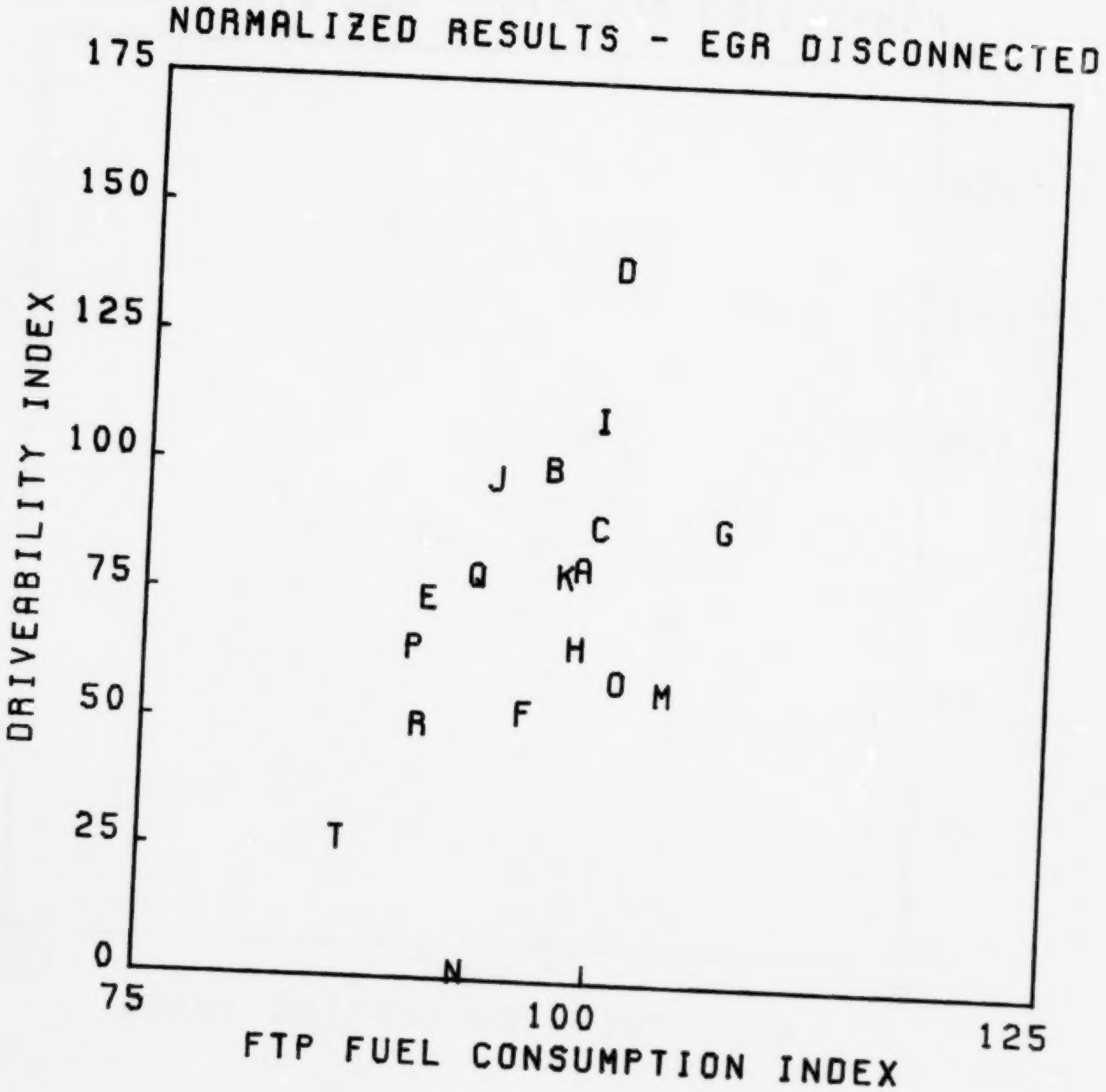

RELATIVE RESULTS FROM VEHICLE V
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
M3
M2
M4
B
M1
75
100
125
HFET FUEL CONSUMPTION INDEX

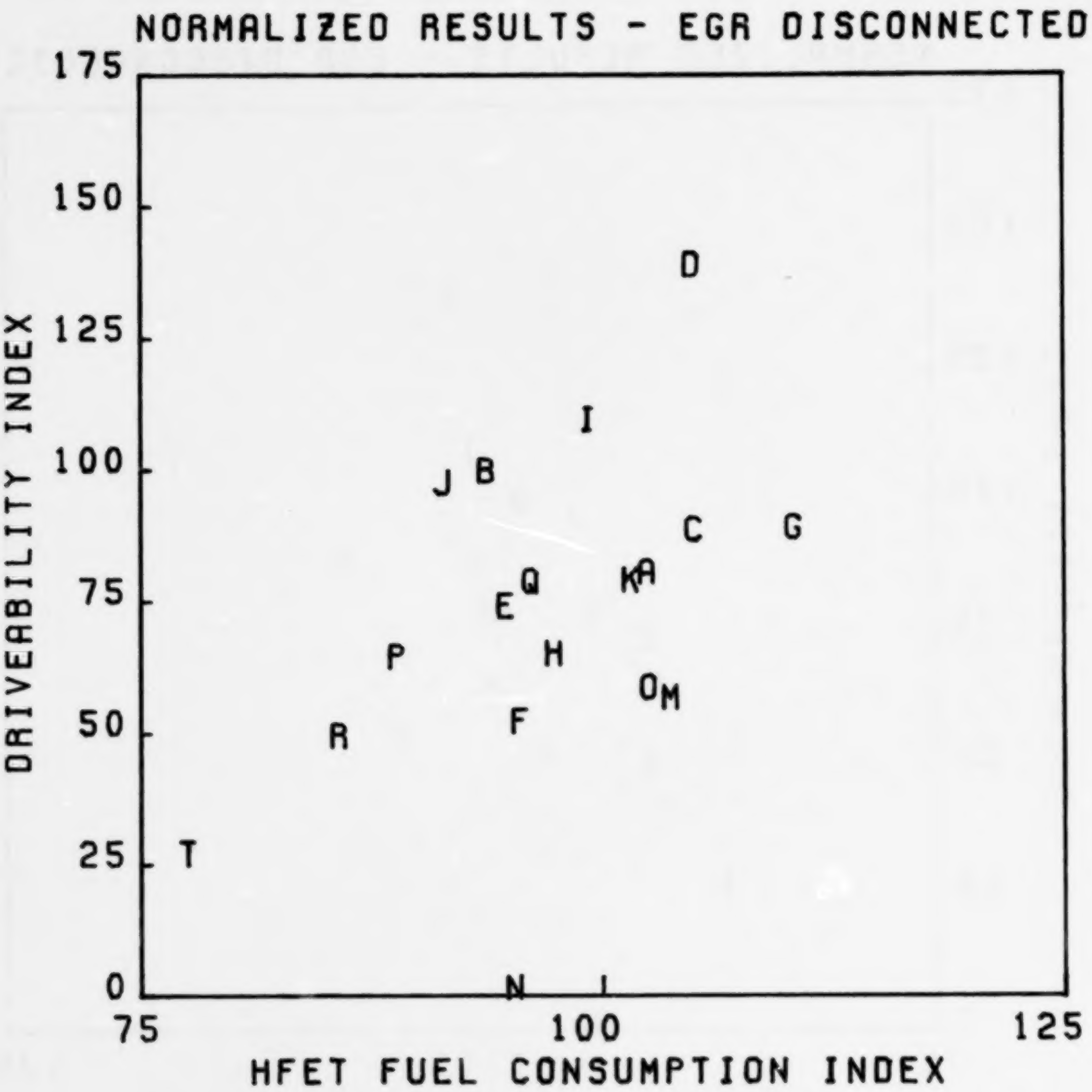

RELATIVE RESULTS FROM VEHICLE V
DRIVEABILITY INDEX
HC EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M3
M2
B
M1
M4

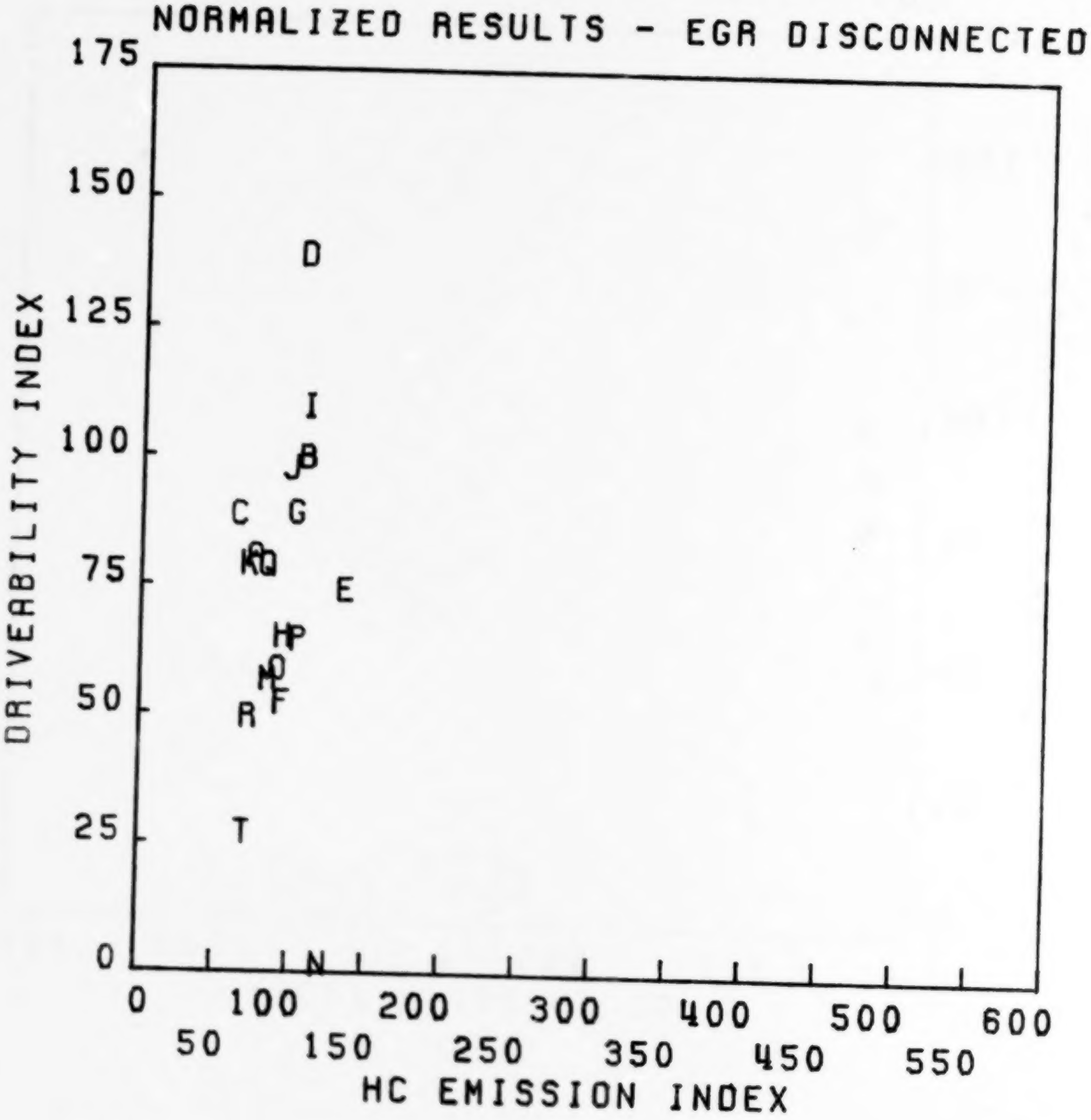

RELATIVE RESULTS FROM VEHICLE V
DRIVEABILITY INDEX
CO EMISSION INDEX
175
150
125
100
75
50
25
0
0
300
600
900
1200
1500
M3
M2
B
M1
M4

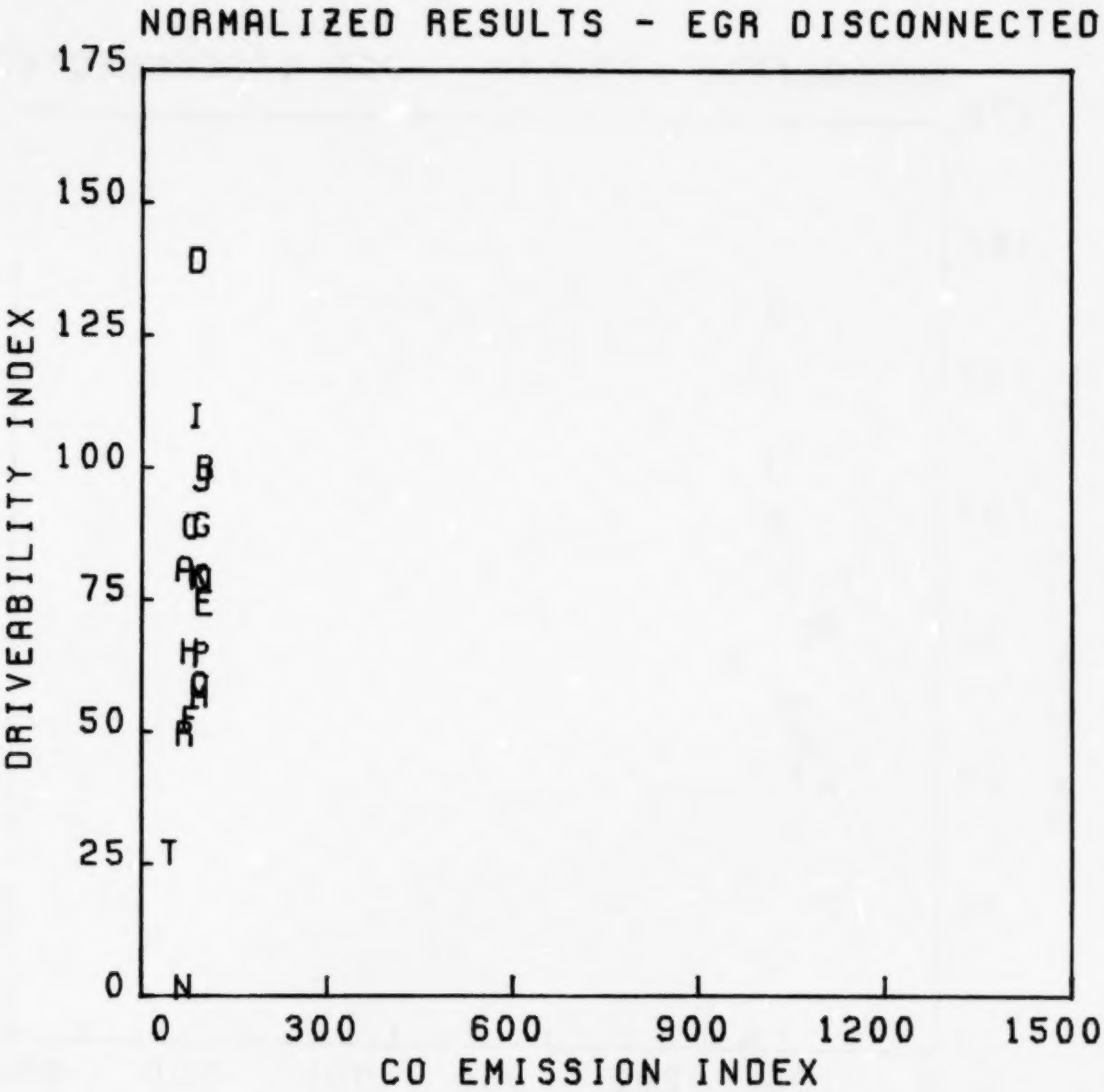

RELATIVE RESULTS FROM VEHICLE V
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
M3
M2
M4
B
M1
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX


NORMALIZED RESULTS - EGR DISCONNECTED
DRIVEABILITY INDEX
ACCELERATION INDEX
0
25
50
75
100
125
150
175
70
80
90
100
110
120
D
I
B
J
G
C
A
E
P
H
O
M
F
R
T
N

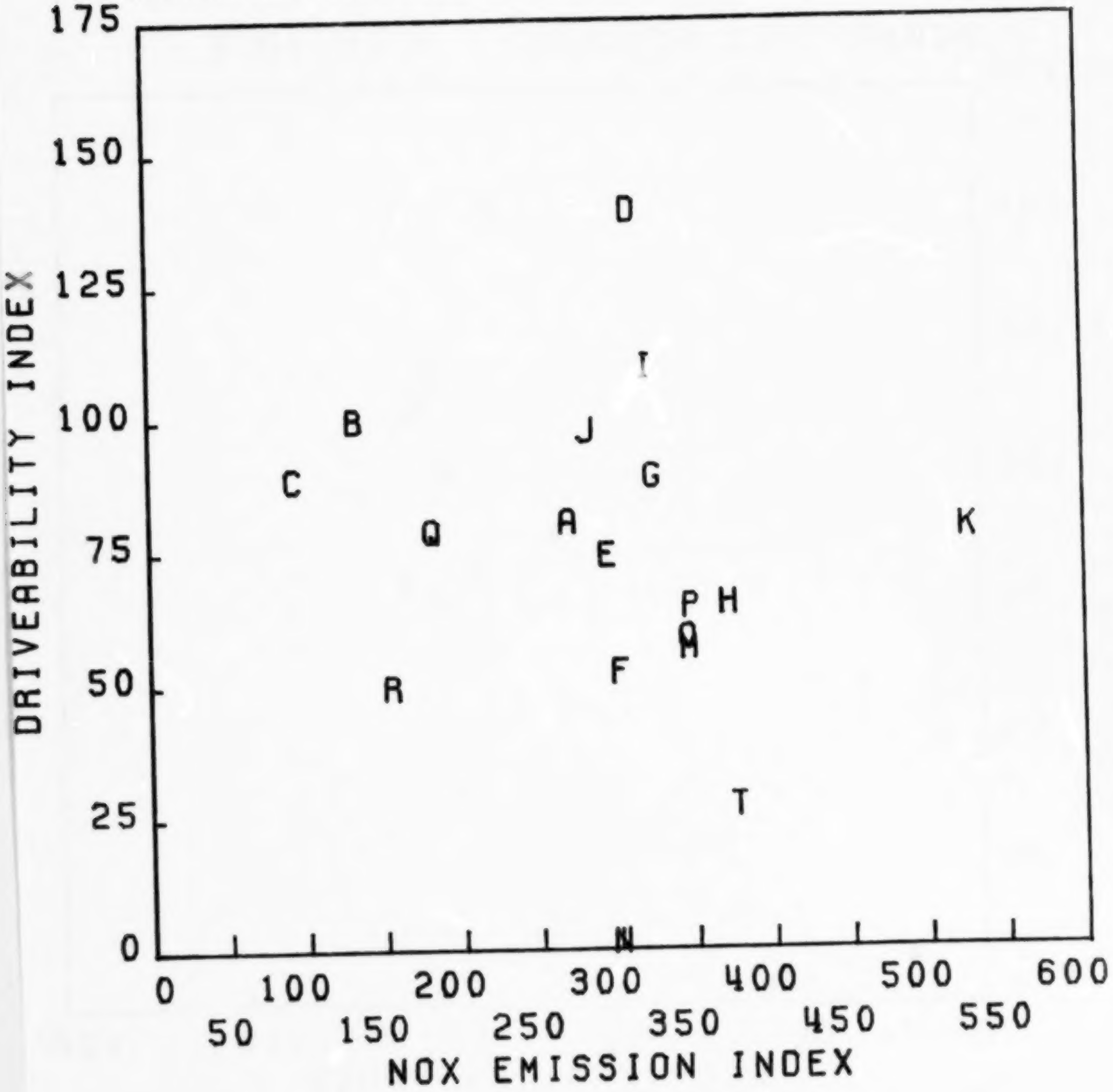

NORMALIZED RESULTS - EGR DISCONNECTED
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
FTP FUEL CONSUMPTION INDEX
75
100
125
D
I
J
B
C
G
Q
K
A
E
P
H
O
M
R
F
T
N

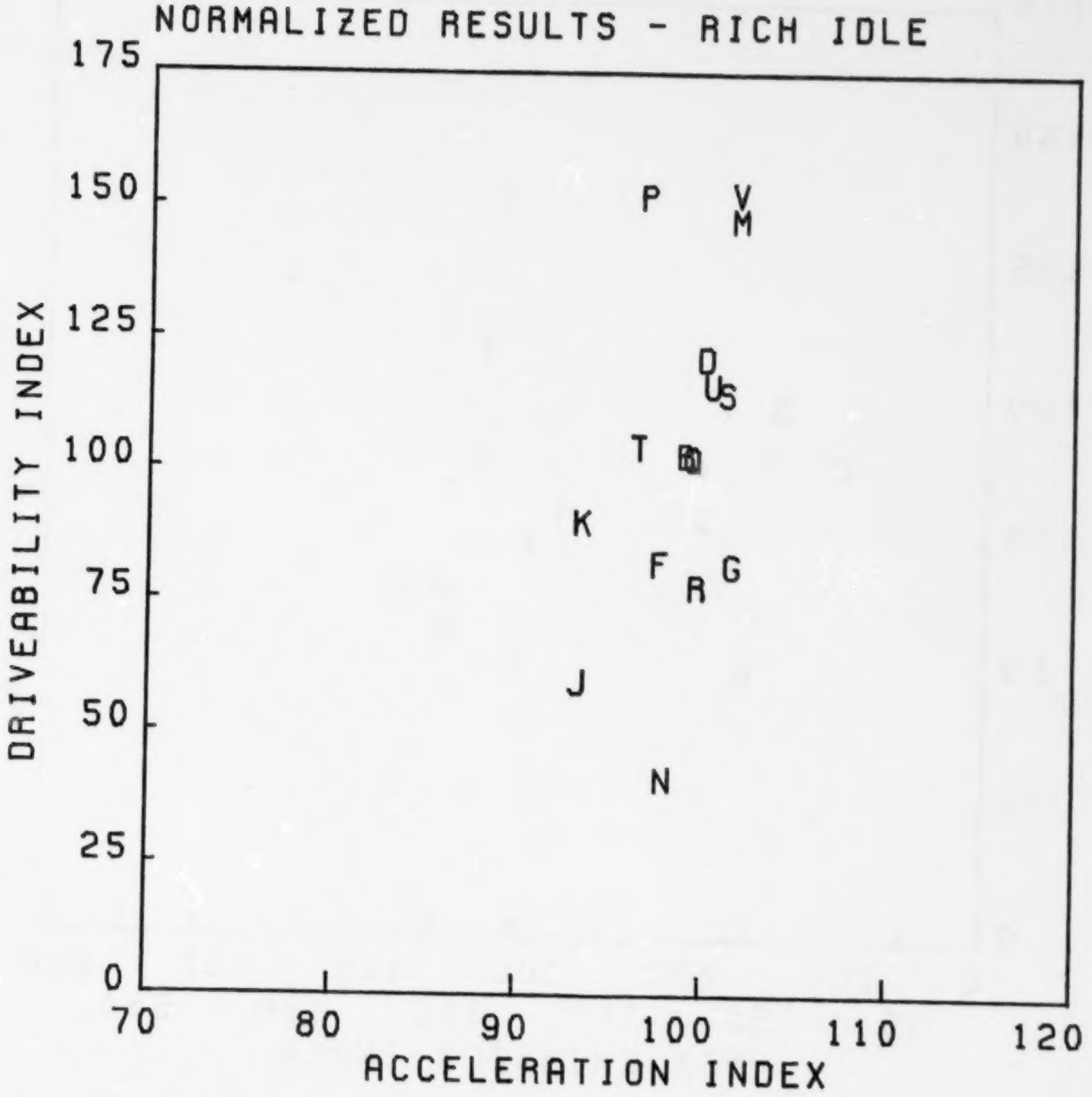

NORMALIZED RESULTS - EGR DISCONNECTED
DRIVEABILITY INDEX
HFET FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
D
I
J
B
C
G
Q
K
A
E
P
H
O
M
F
R
T
N

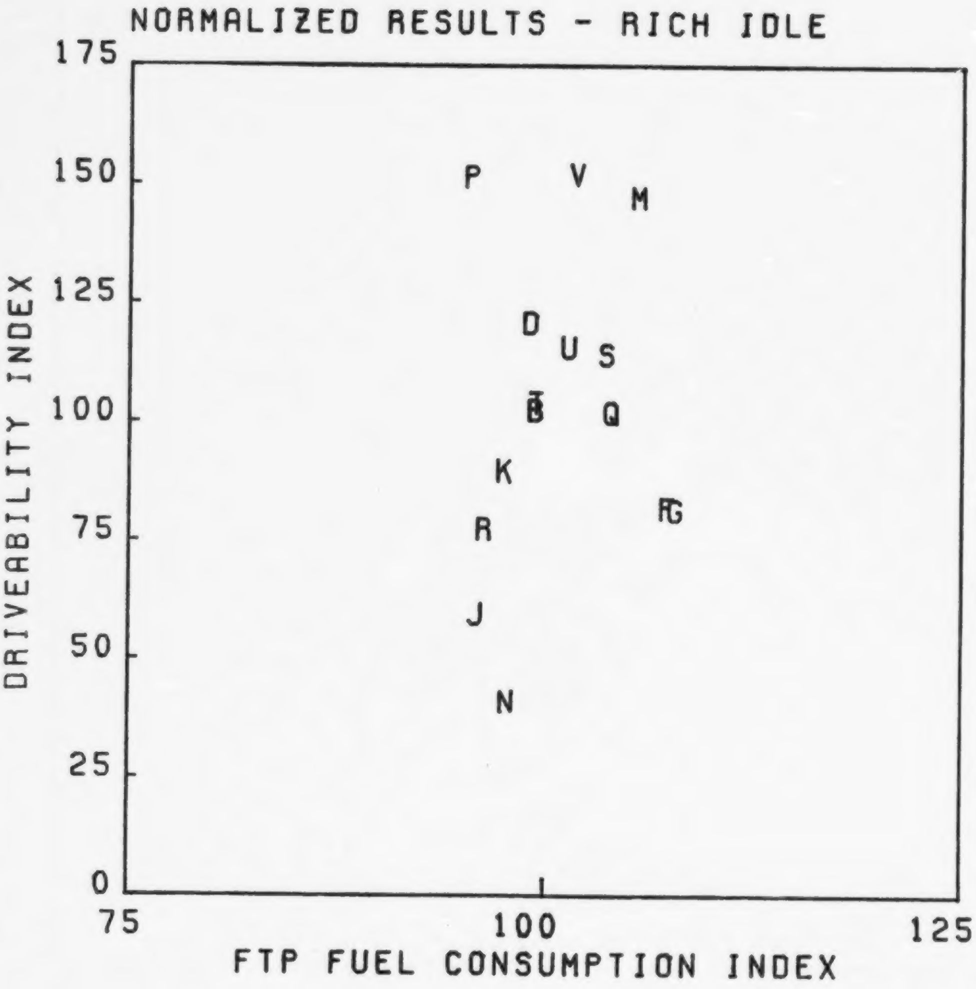

NORMALIZED RESULTS - EGR DISCONNECTED
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
HC EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
D
I
B
J
C
G
K
Q
E
H
P
O
M
F
R
T
N

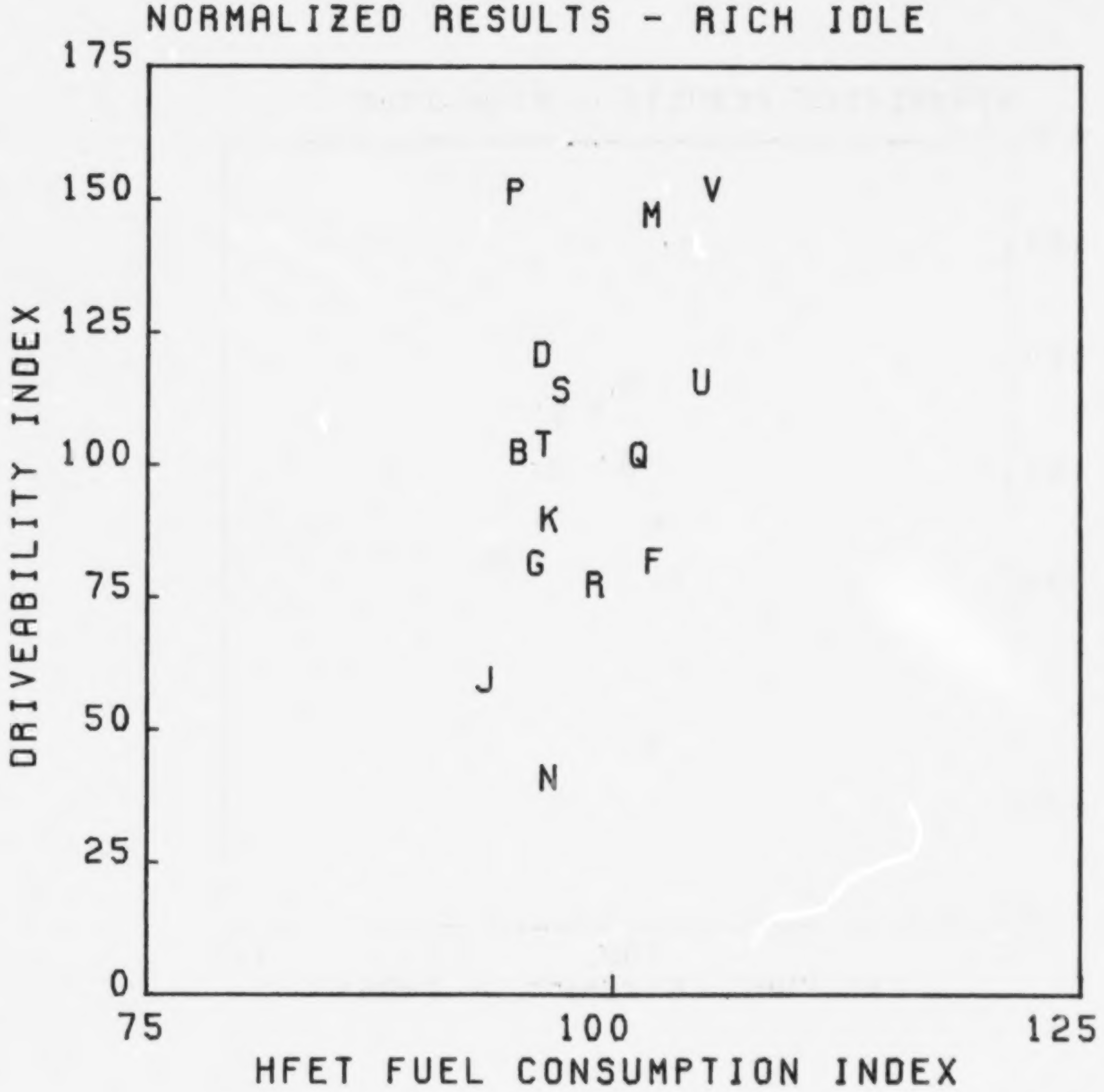

NORMALIZED RESULTS - EGR DISCONNECTED
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
CO EMISSION INDEX
0
300
600
900
1200
1500
D
I
B
J
C
G
A
N
M
E
H
P
Q
L
F
R
T
N

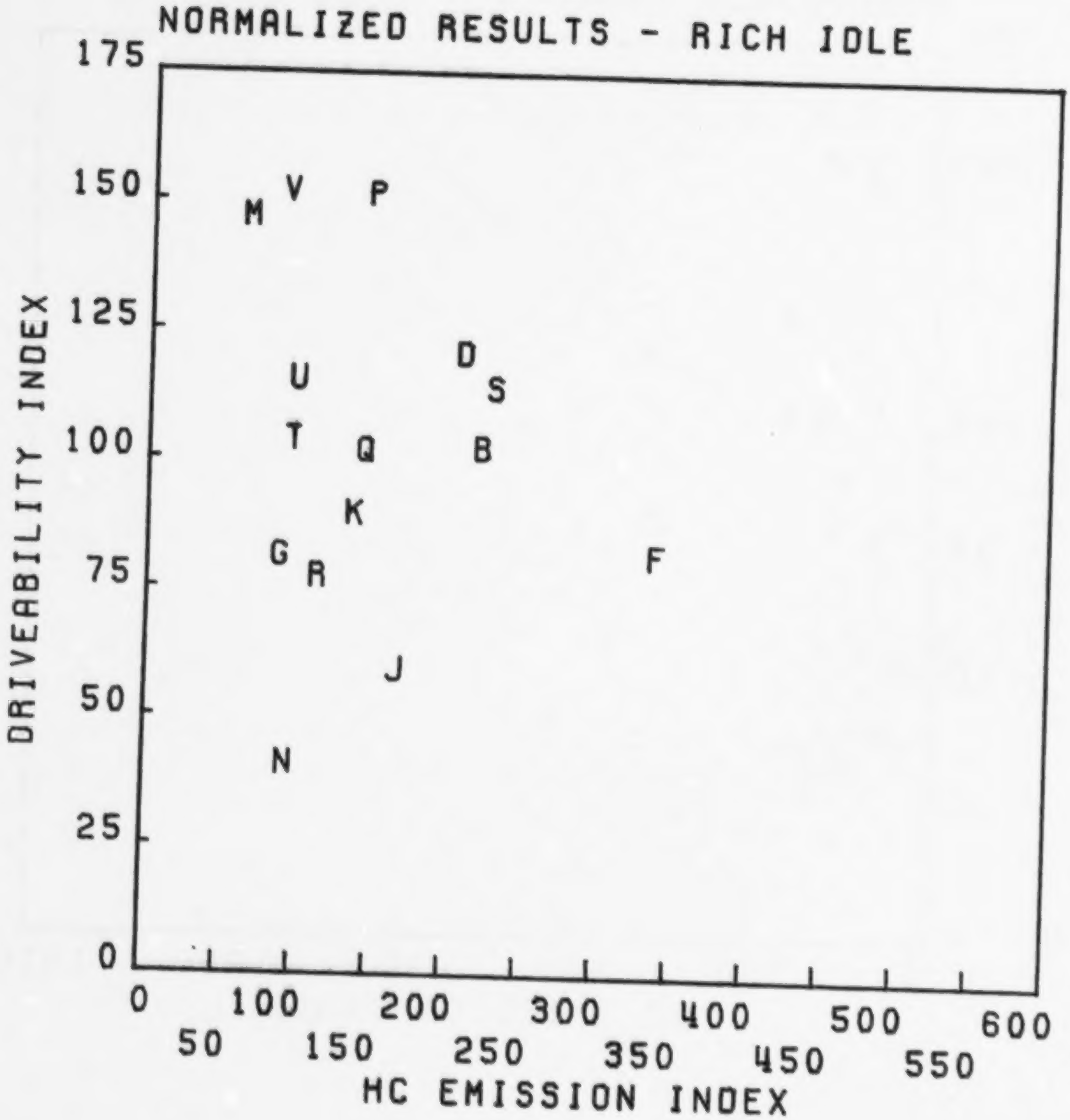
NORMALIZED RESULTS - EGR DISCONNECTED

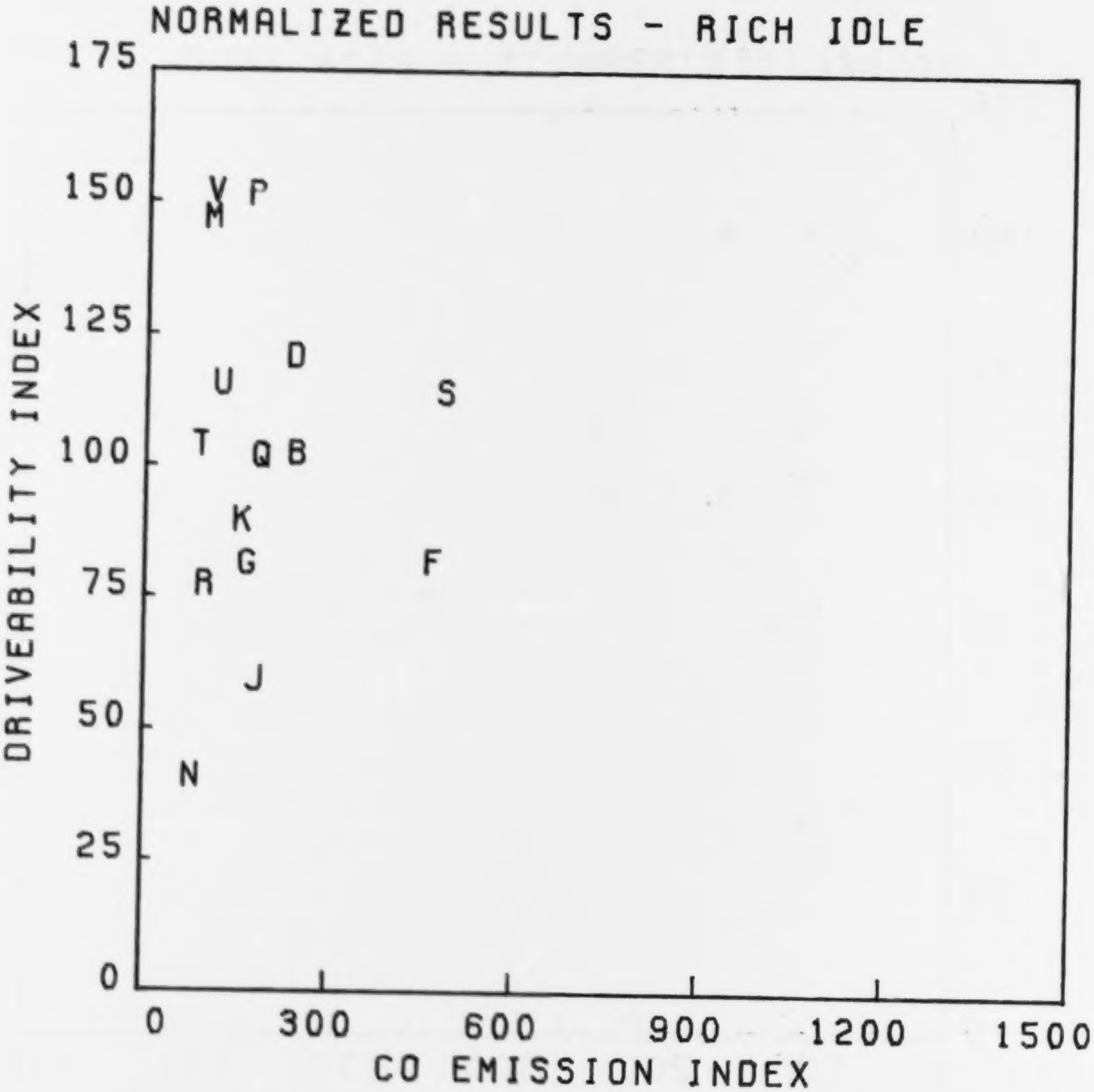


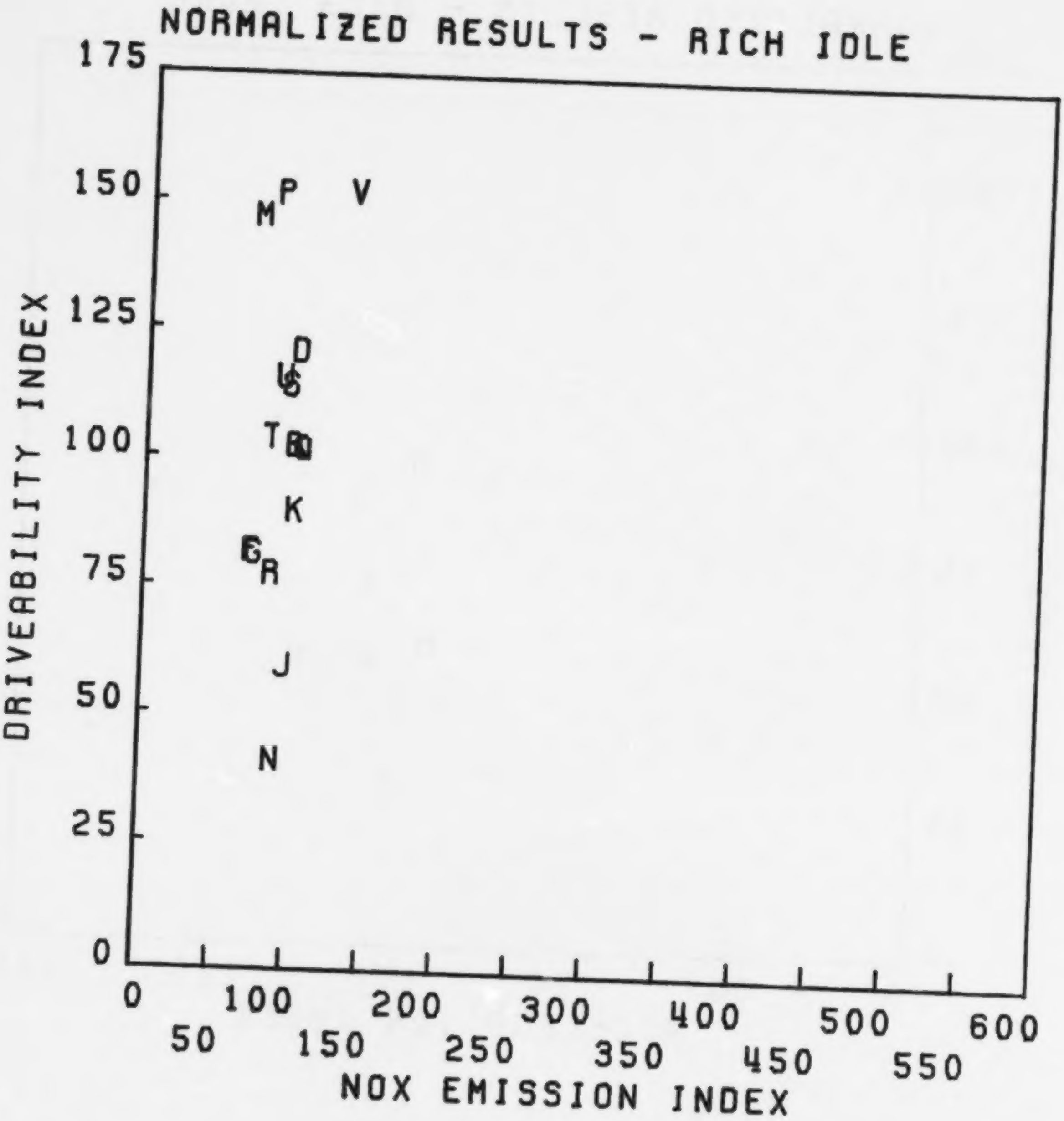

NORMALIZED RESULTS - RICH IDLE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
70
80
90
100
110
120
ACCELERATION INDEX
P
V
M
D
U
S
T
K
F
R
G
J
N

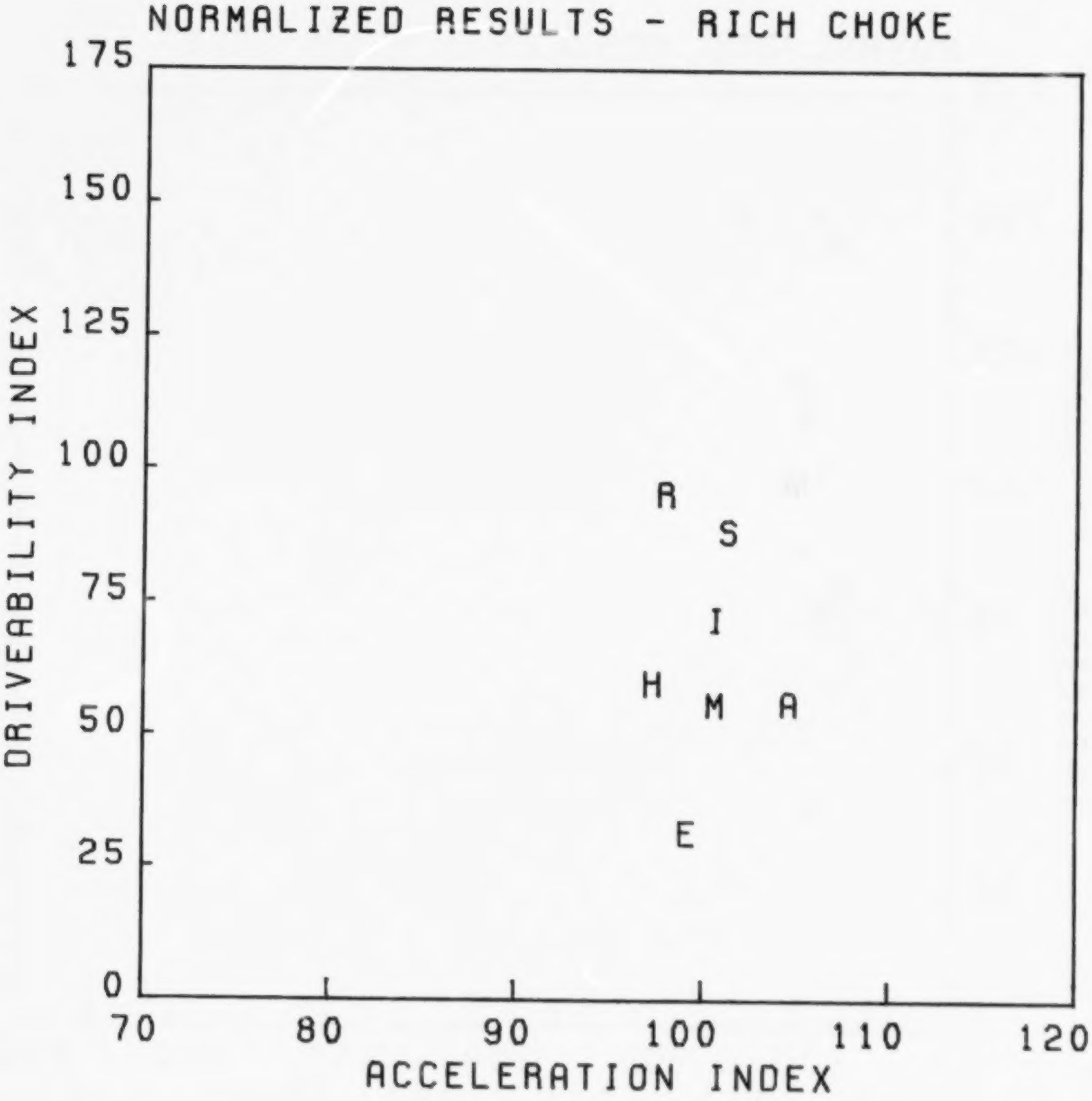

NORMALIZED RESULTS - RICH IDLE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
FTP FUEL CONSUMPTION INDEX
75
100
125
P
V
M
D
U
S
B
Q
K
FG
R
J
N

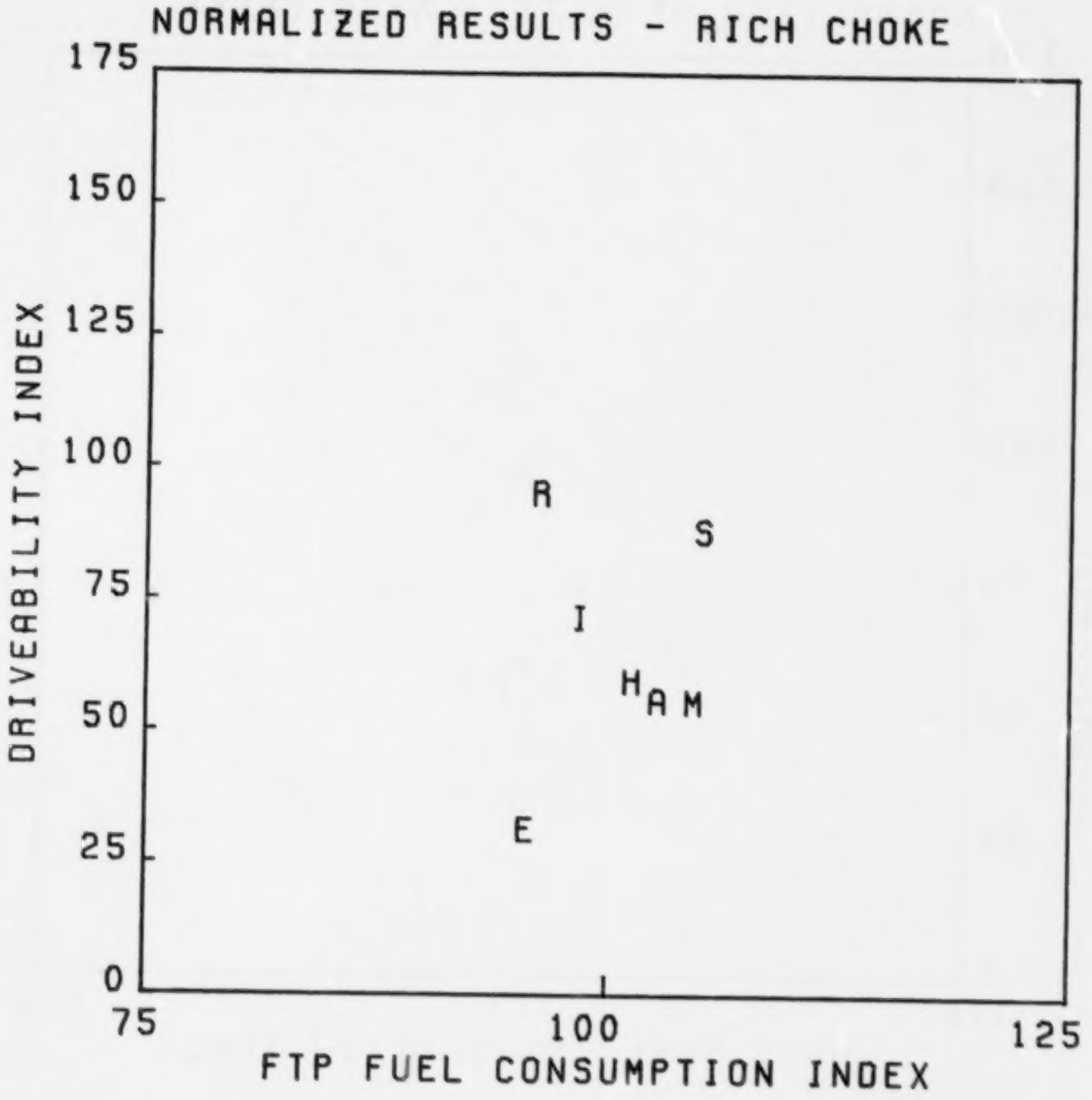

NORMALIZED RESULTS - RICH IDLE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
HFET FUEL CONSUMPTION INDEX
P
V
M
D
S
U
B
T
Q
K
G
F
R
J
N

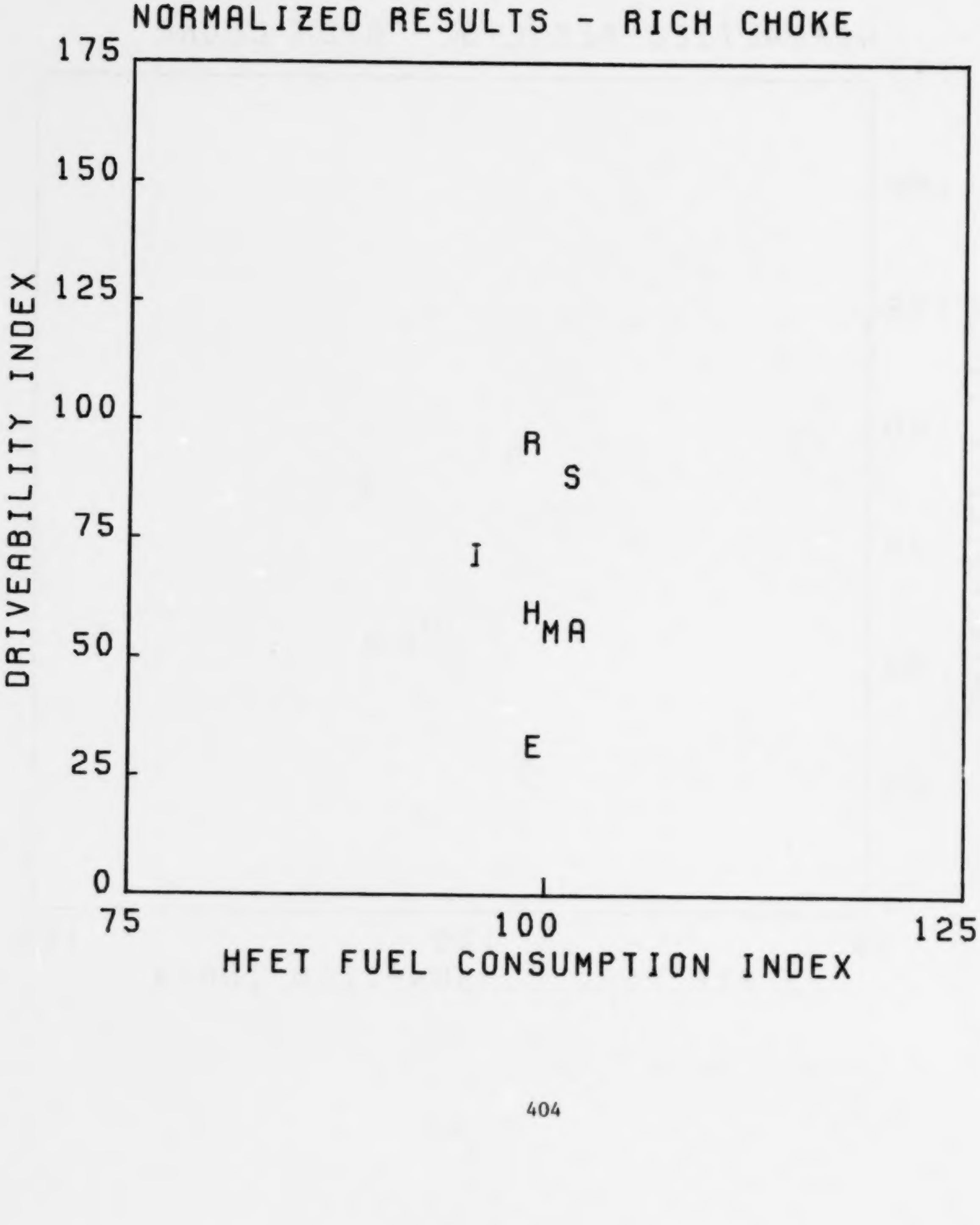

NORMALIZED RESULTS - RICH IDLE
DRIVEABILITY INDEX
HC EMISSION INDEX
175
150
125
100
75
50
25
0
0
50
100
150
200
250
300
350
400
450
500
550
600
M
V
P
U
D
S
T
Q
B
K
G
R
F
J
N

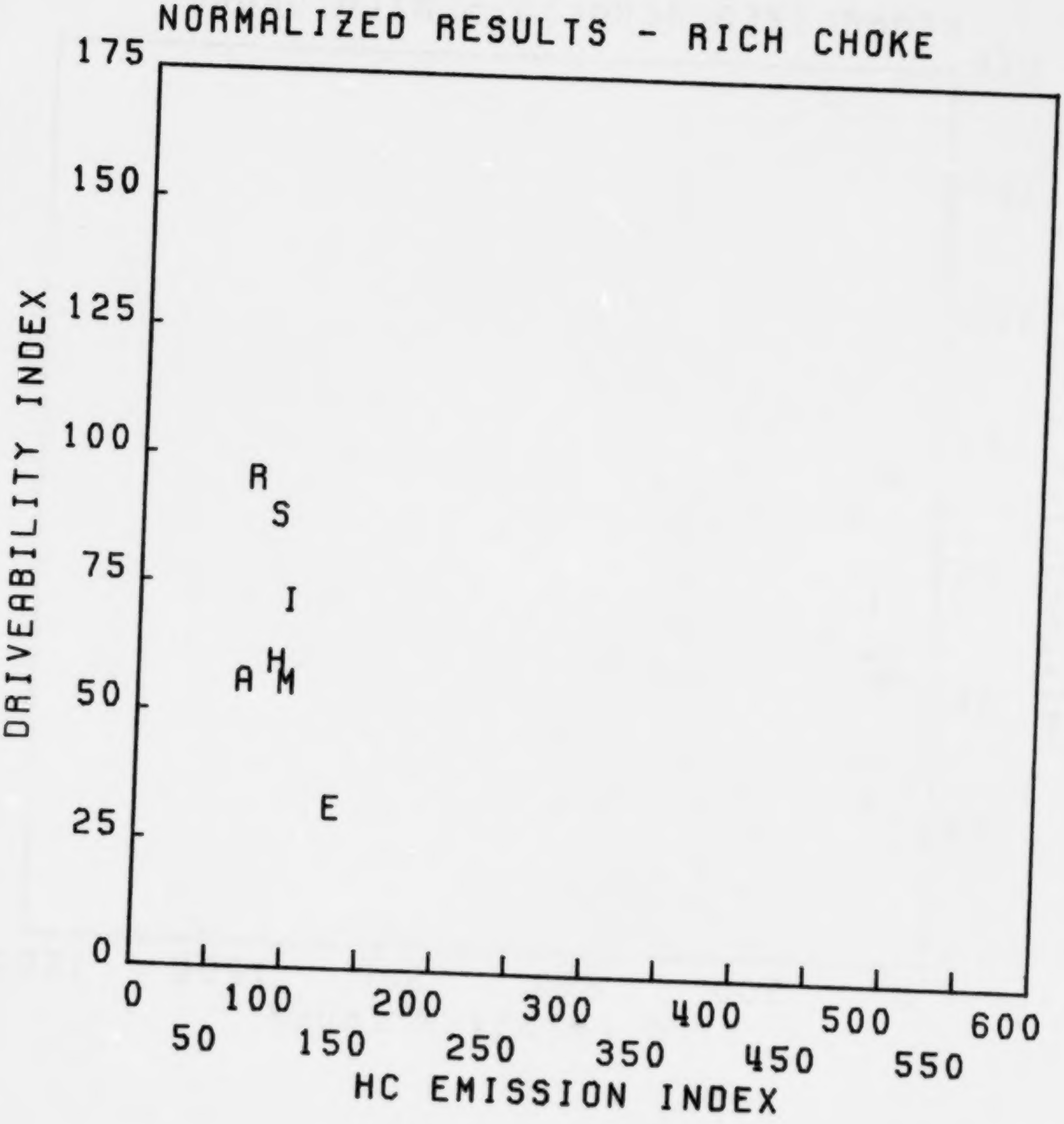

NORMALIZED RESULTS - RICH IDLE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
CO EMISSION INDEX
0
300
600
900
1200
1500
V
P
M
D
U
S
T
Q
B
K
G
F
R
J
N

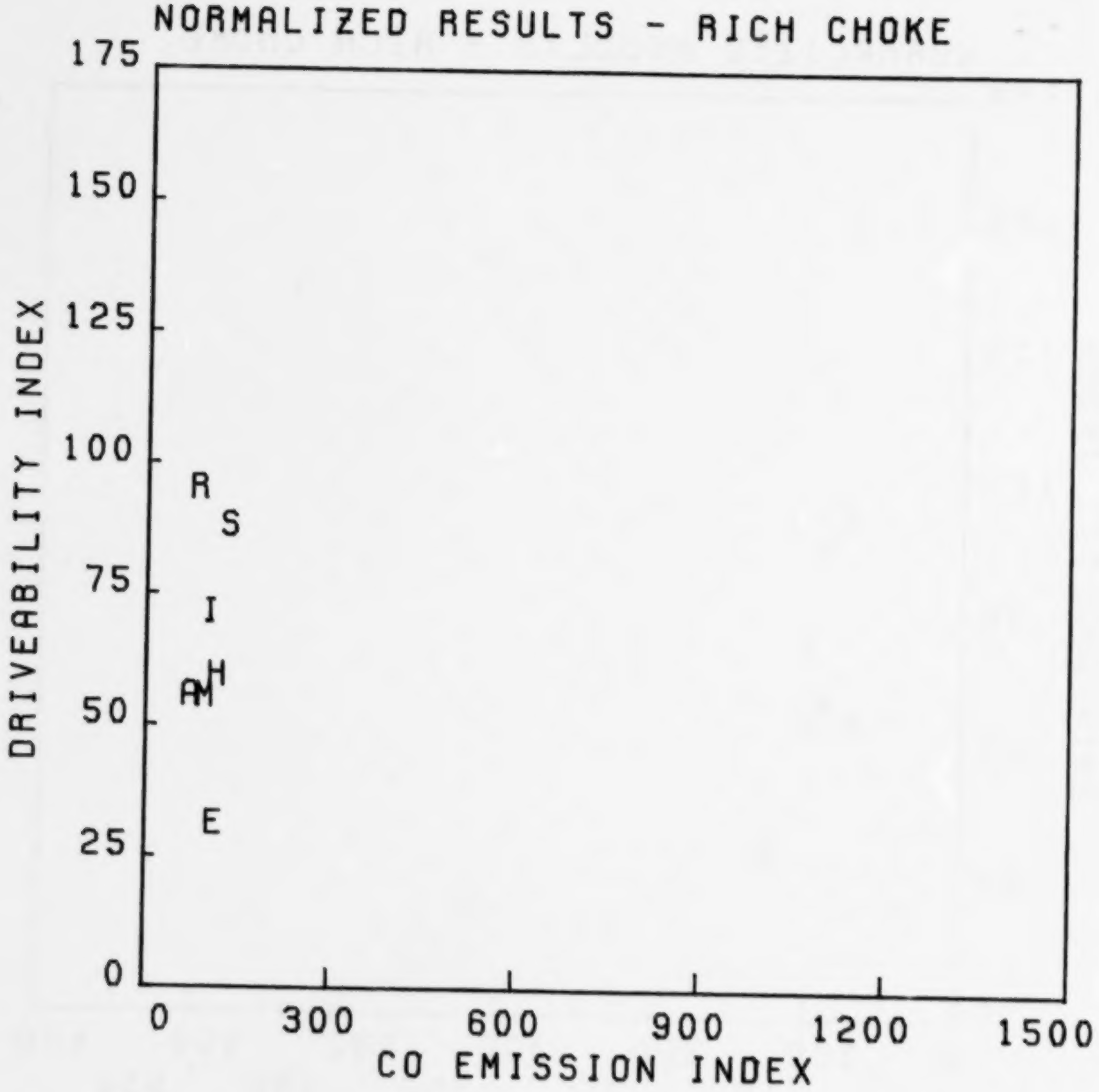

NORMALIZED RESULTS - RICH IDLE
DRIVEABILITY INDEX
NOX EMISSION INDEX
0
25
50
75
100
125
150
175
0
50
100
150
200
250
300
350
400
450
500
550
600
M
P
V
D
U
S
T
B
Q
K
E
G
R
J
N

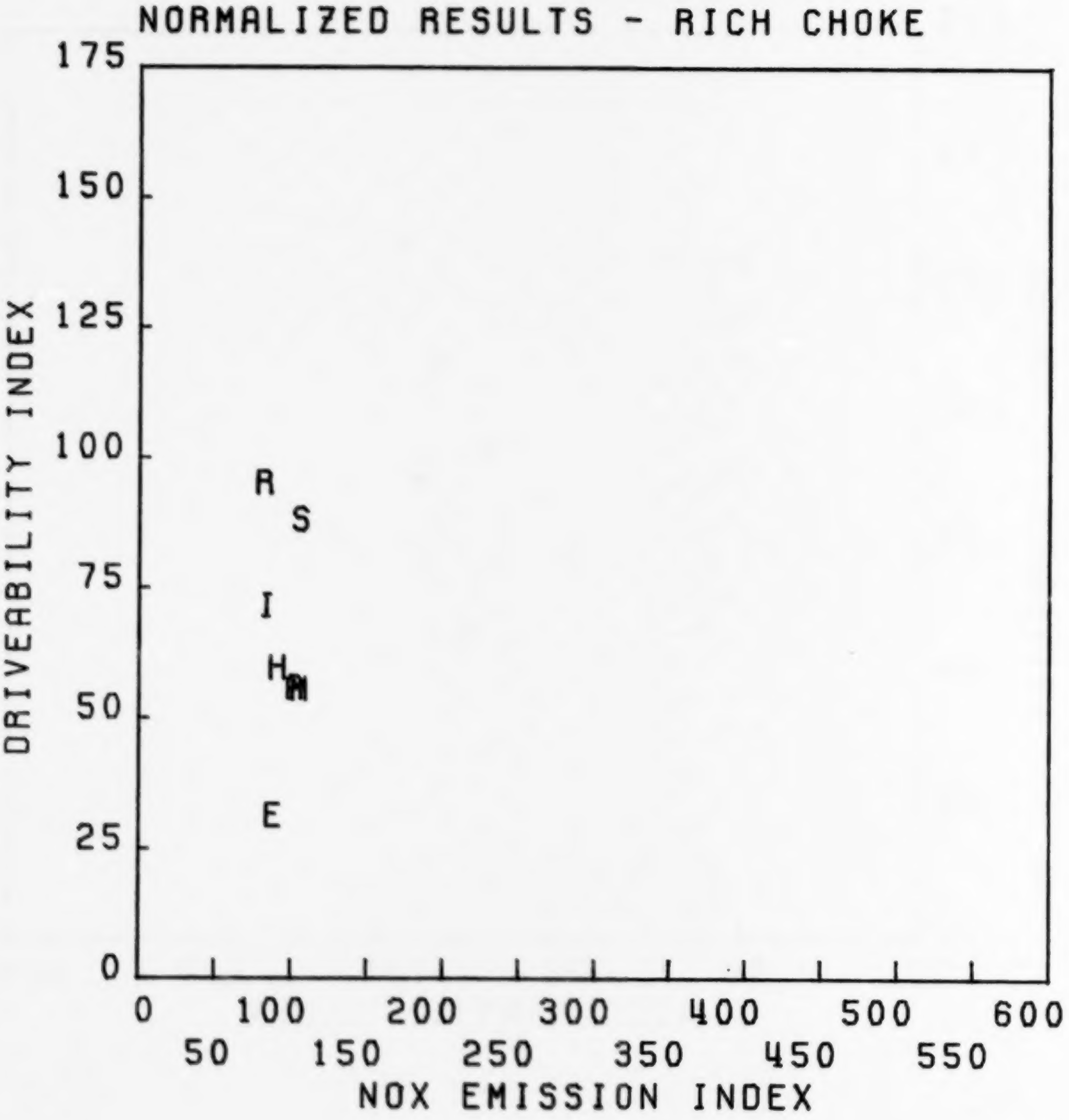

NORMALIZED RESULTS - RICH CHOKE
175
150
125
100
75
50
25
0
70
80
90
100
110
120
ACCELERATION INDEX
DRIVEABILITY INDEX
R
S
I
H
M
A
E

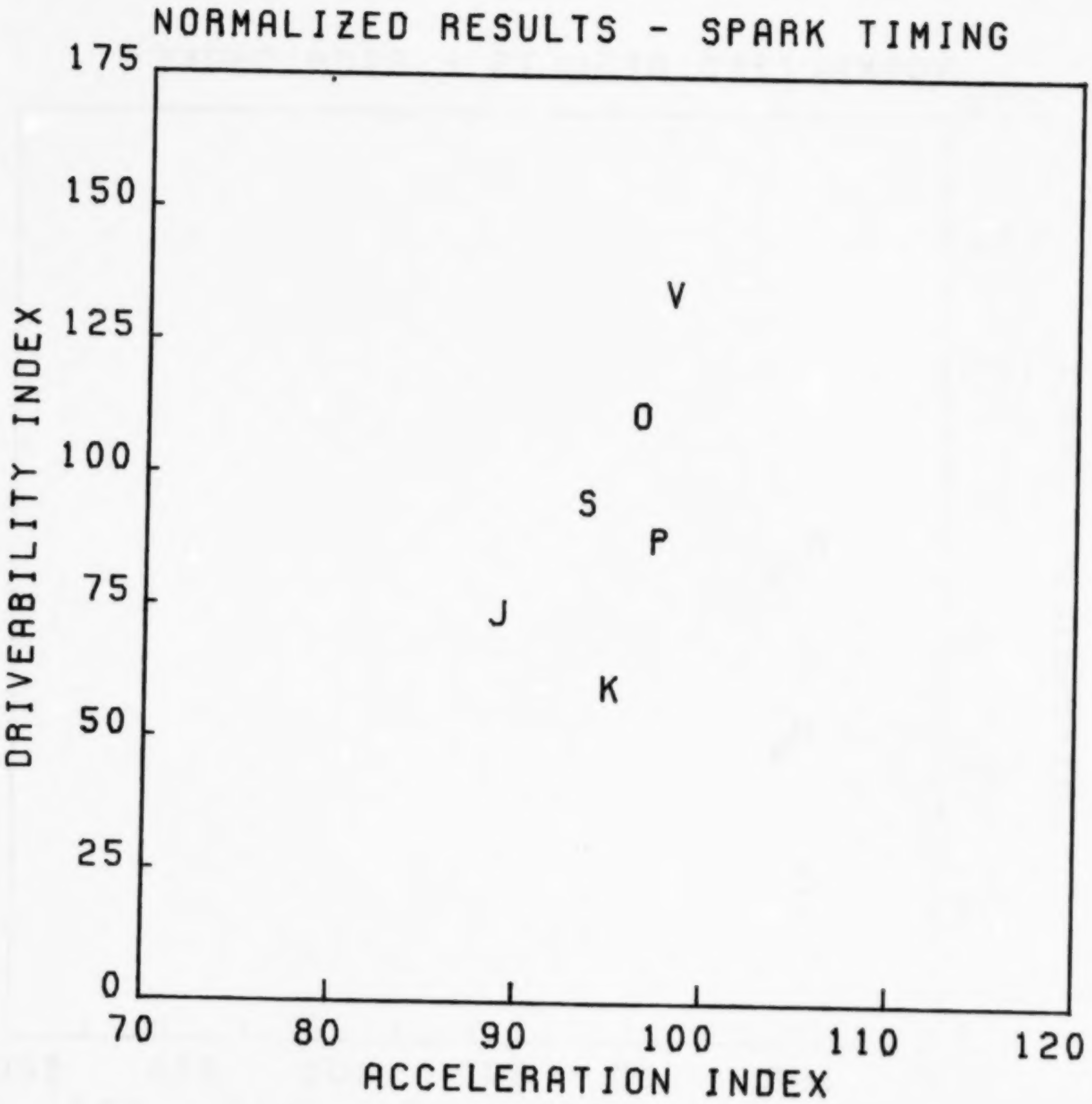

NORMALIZED RESULTS - RICH CHOKE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
FTP FUEL CONSUMPTION INDEX
R
S
I
H
A
M
E

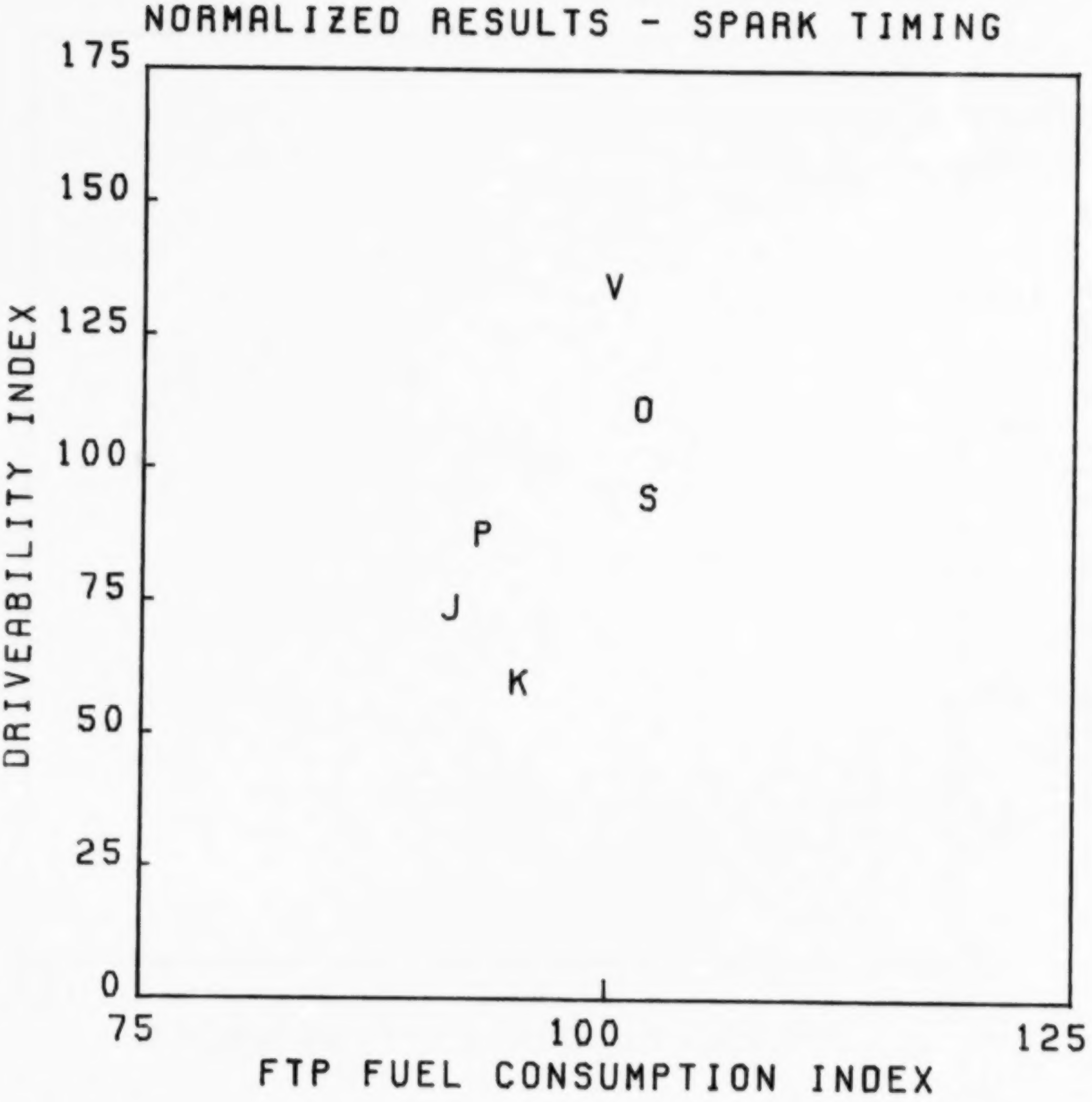

NORMALIZED RESULTS - RICH CHOKE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
HFET FUEL CONSUMPTION INDEX
R
S
I
H
M
A
E

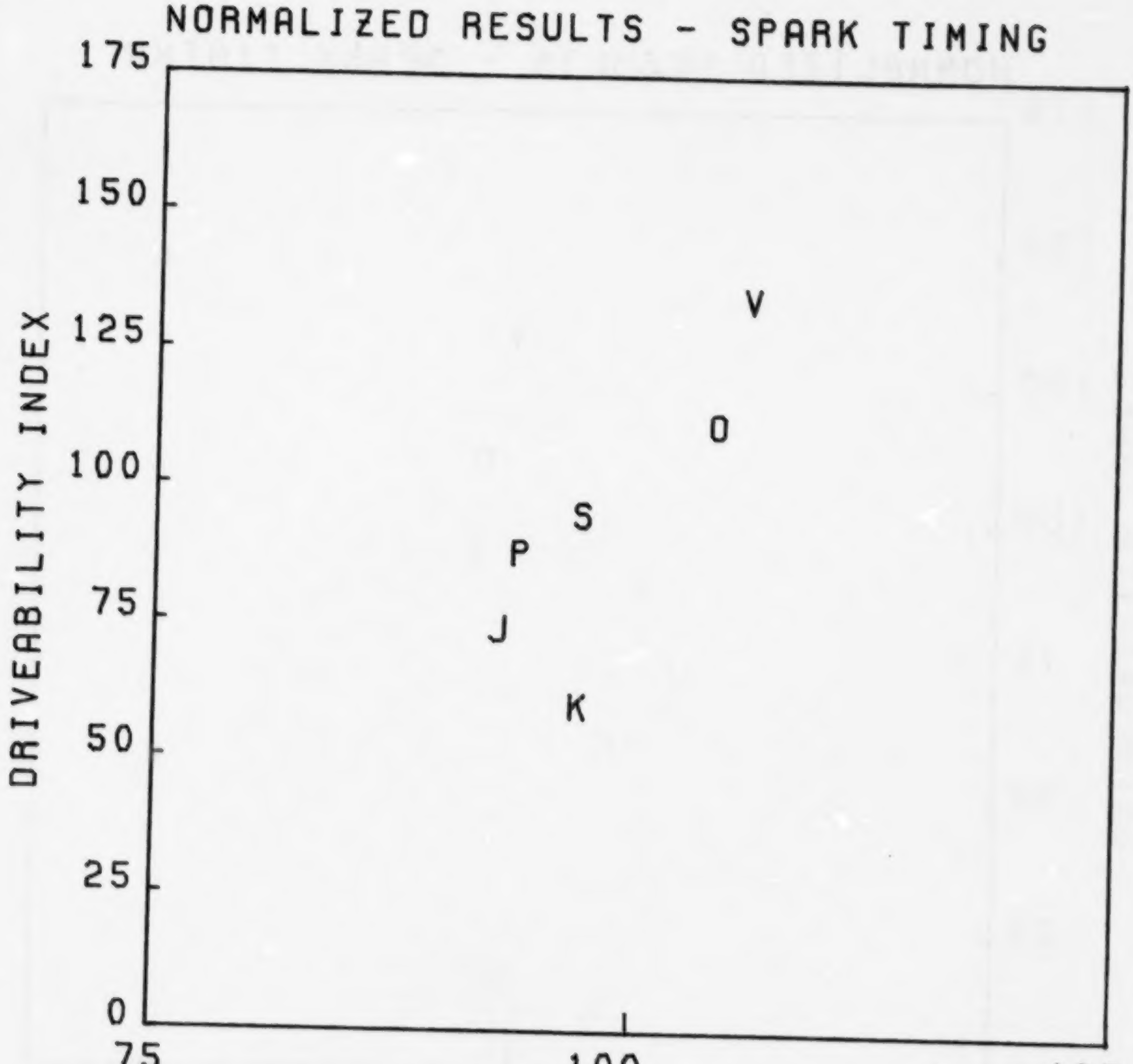

NORMALIZED RESULTS - RICH CHOKE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
R
S
I
H
A
M
E
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX

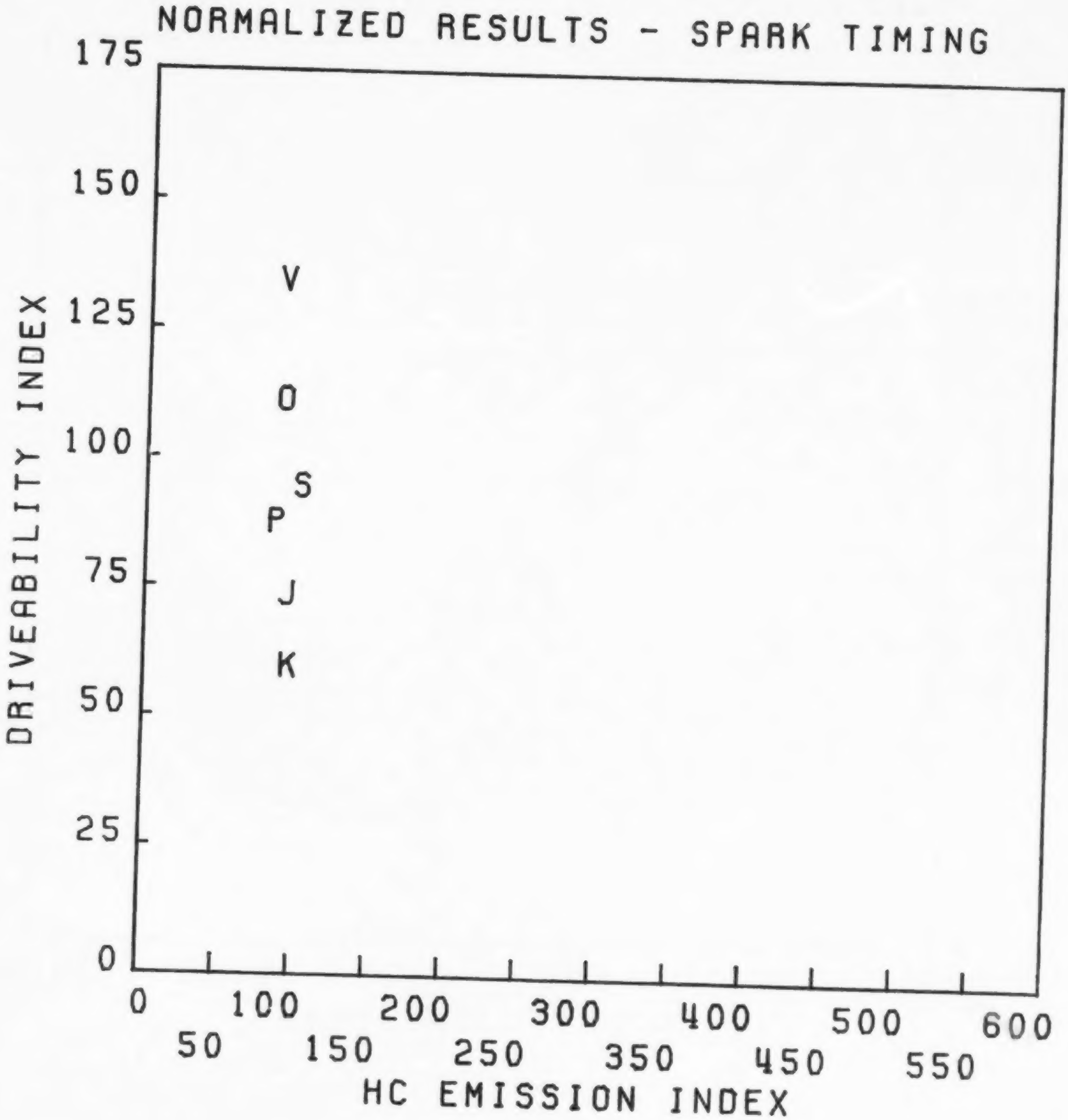

NORMALIZED RESULTS - RICH CHOKE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
CO EMISSION INDEX
0
300
600
900
1200
1500
R
S
I
H
A
M
E

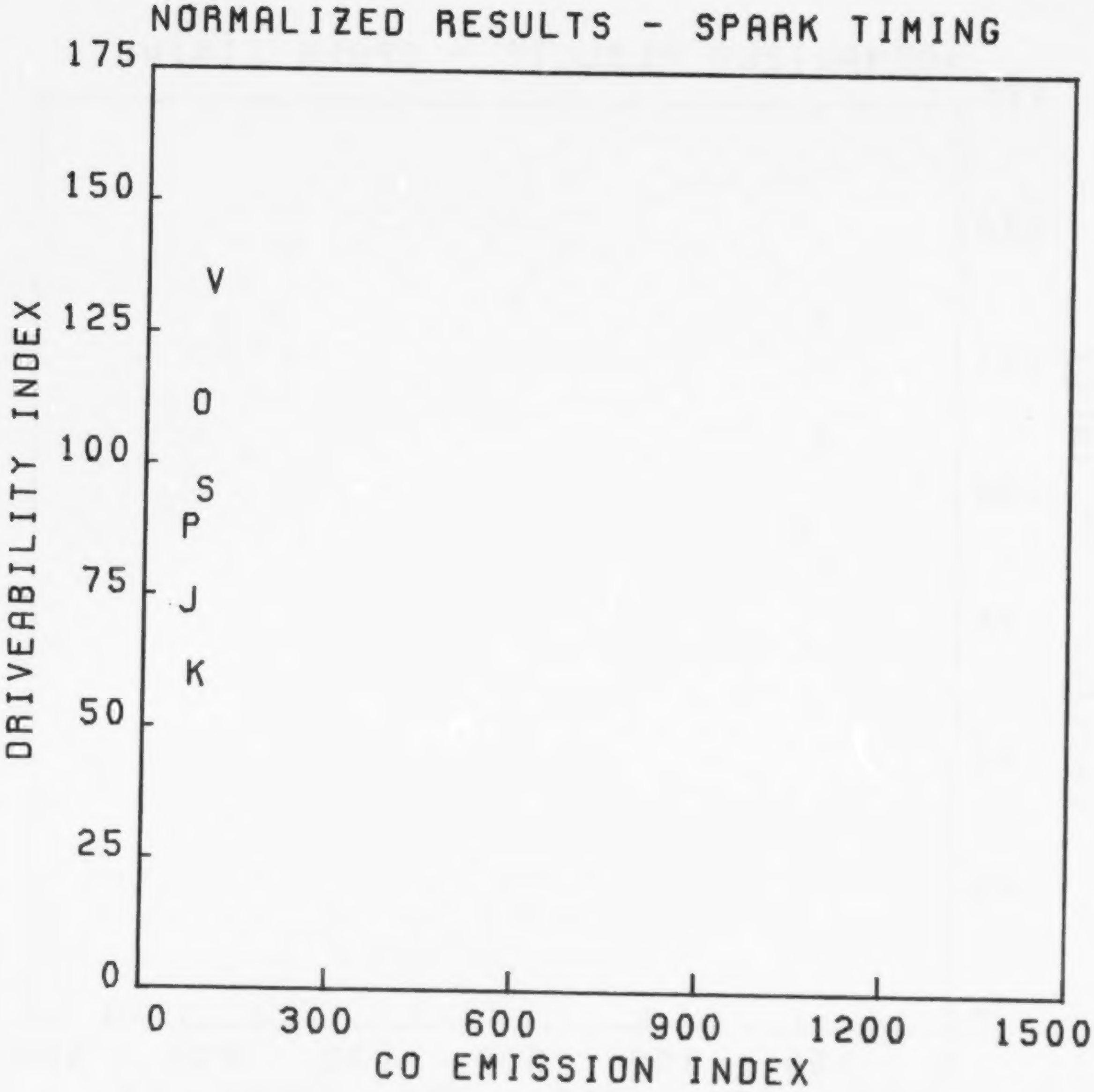

NORMALIZED RESULTS - RICH CHOKE
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
R
S
I
H
A
E
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX

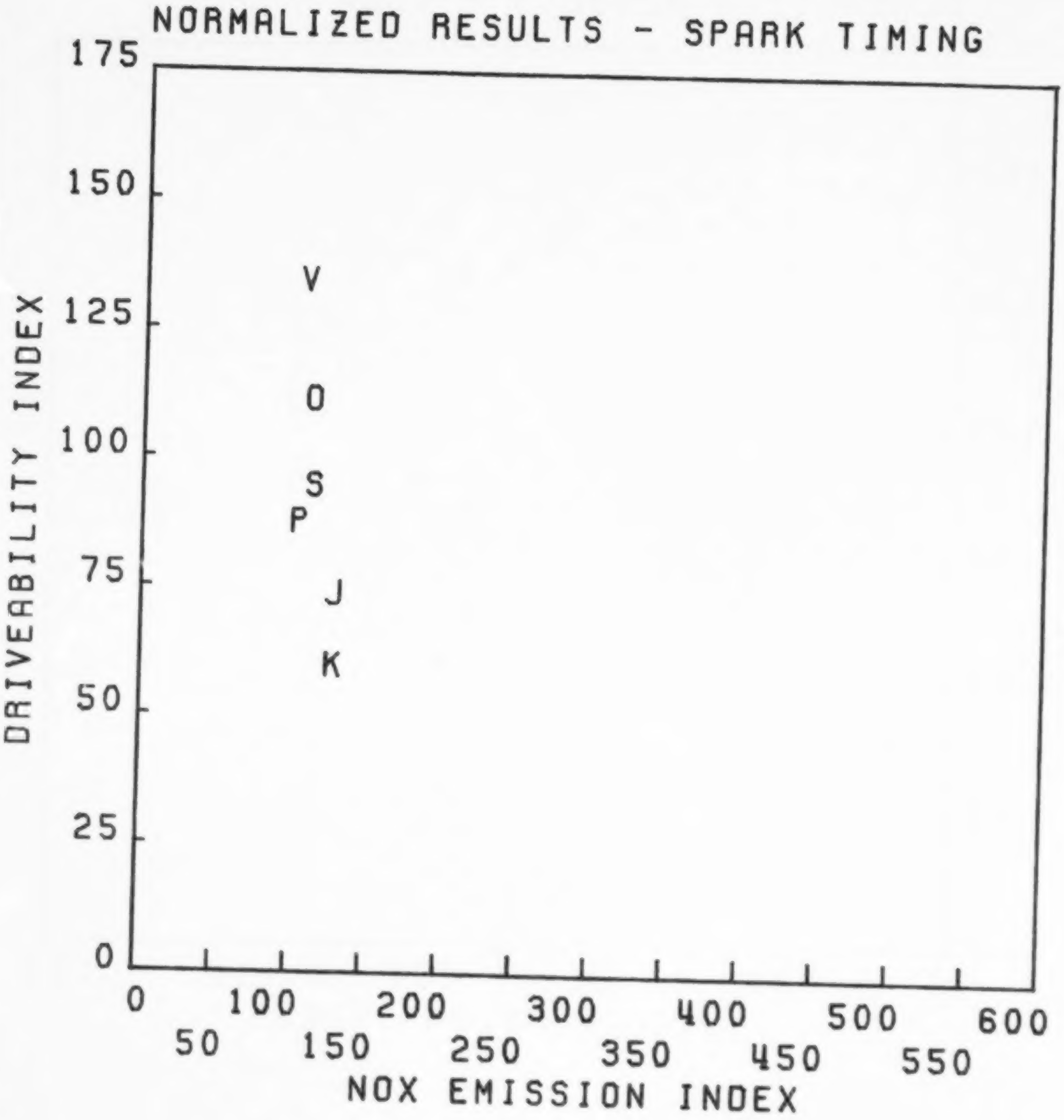

NORMALIZED RESULTS - SPARK TIMING
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
V
O
S
P
J
K
70
80
90
100
110
120
ACCELERATION INDEX

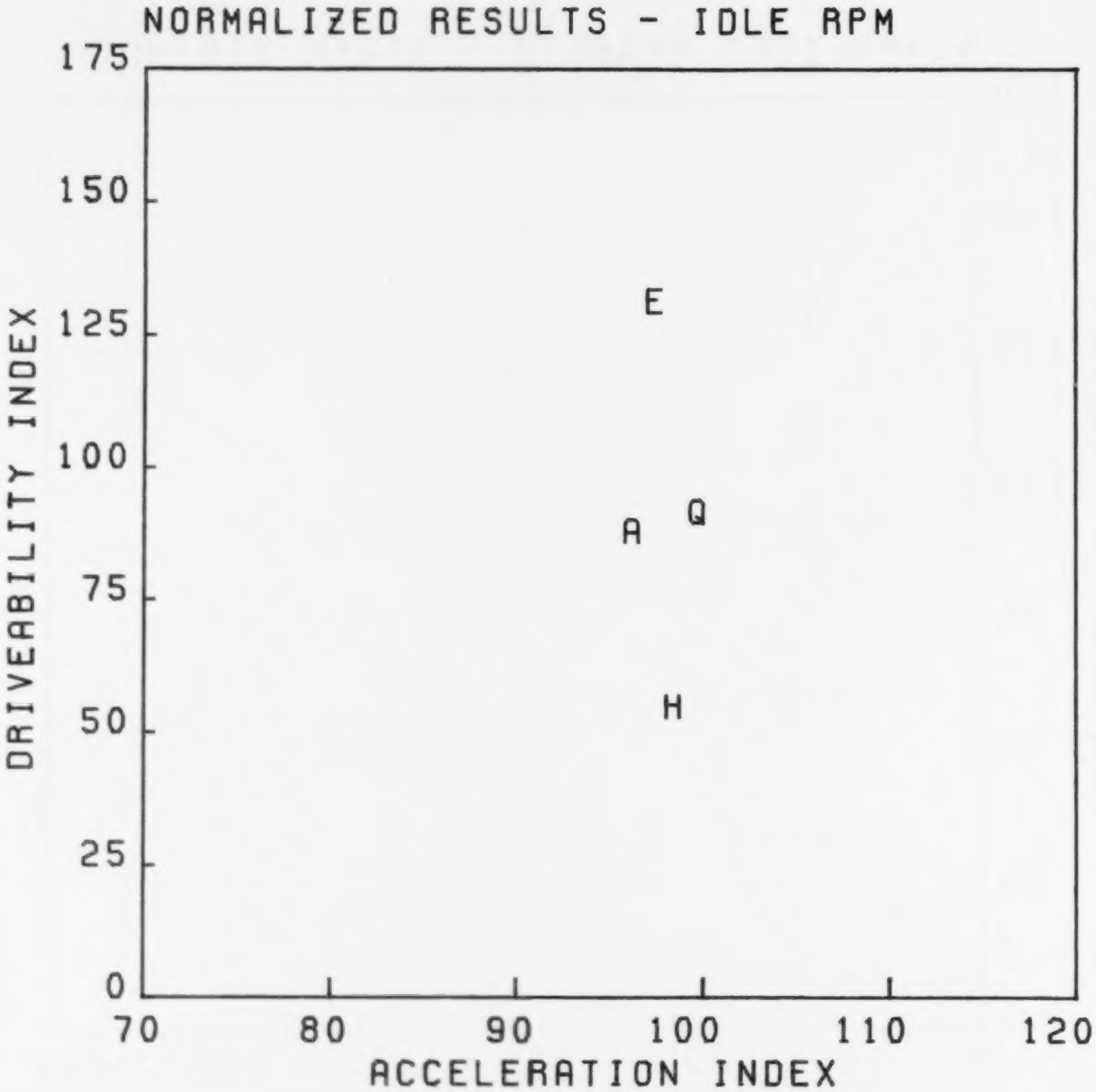

NORMALIZED RESULTS - SPARK TIMING
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
V
O
S
P
J
K
75
100
125
FTP FUEL CONSUMPTION INDEX

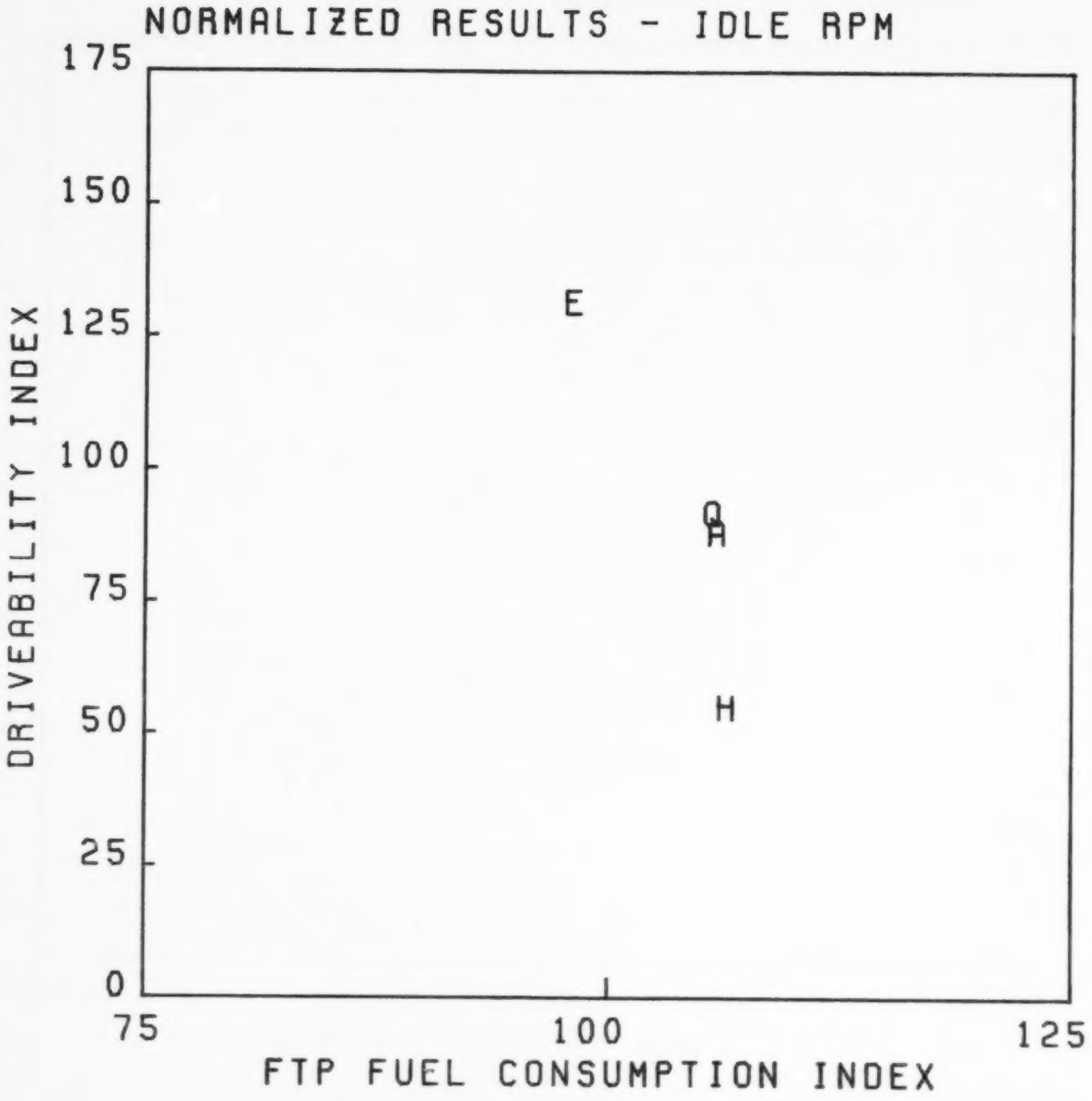

NORMALIZED RESULTS - SPARK TIMING
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
HFET FUEL CONSUMPTION INDEX
V
O
S
P
J
K

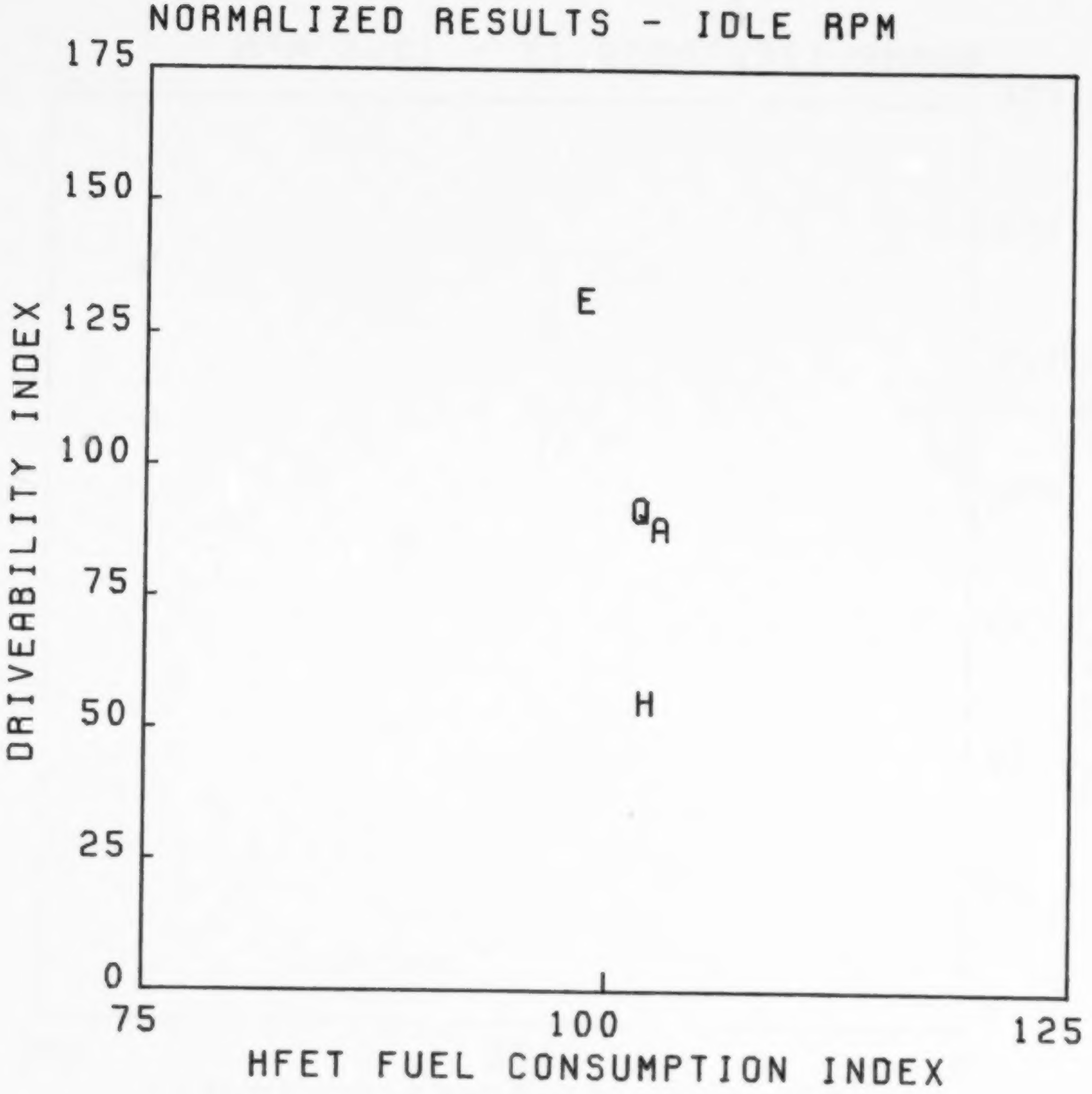

NORMALIZED RESULTS - SPARK TIMING
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
V
O
S
P
J
K
0
100
200
300
400
500
600
50
150
250
350
450
550
HC EMISSION INDEX

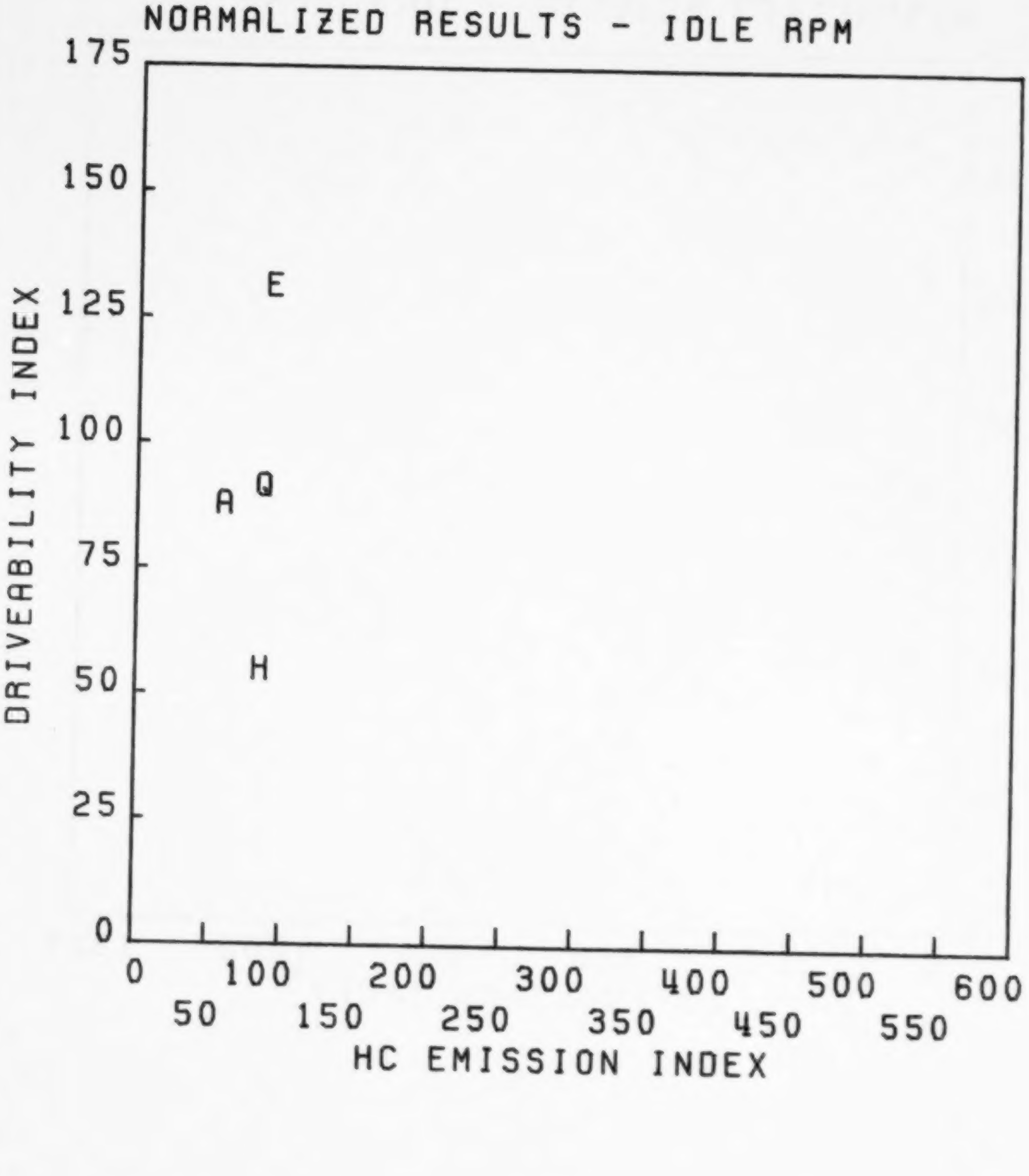

NORMALIZED RESULTS - SPARK TIMING
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
V
O
S
P
J
K
0
300
600
900
1200
1500
CO EMISSION INDEX

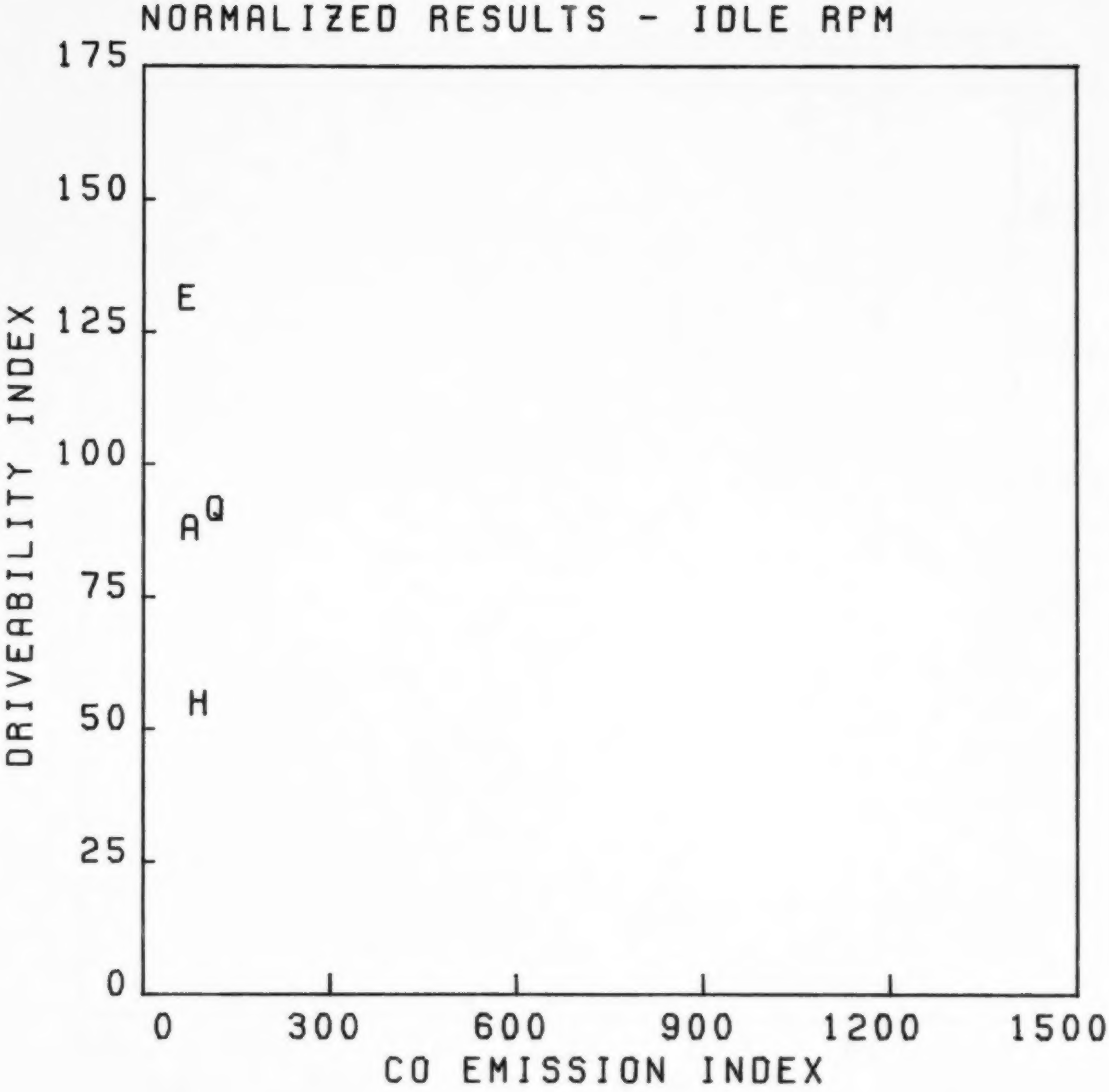

NORMALIZED RESULTS - SPARK TIMING
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
V
O
S
P
J
K
0
50
100
150
200
250
300
350
400
450
500
550
600
NOX EMISSION INDEX

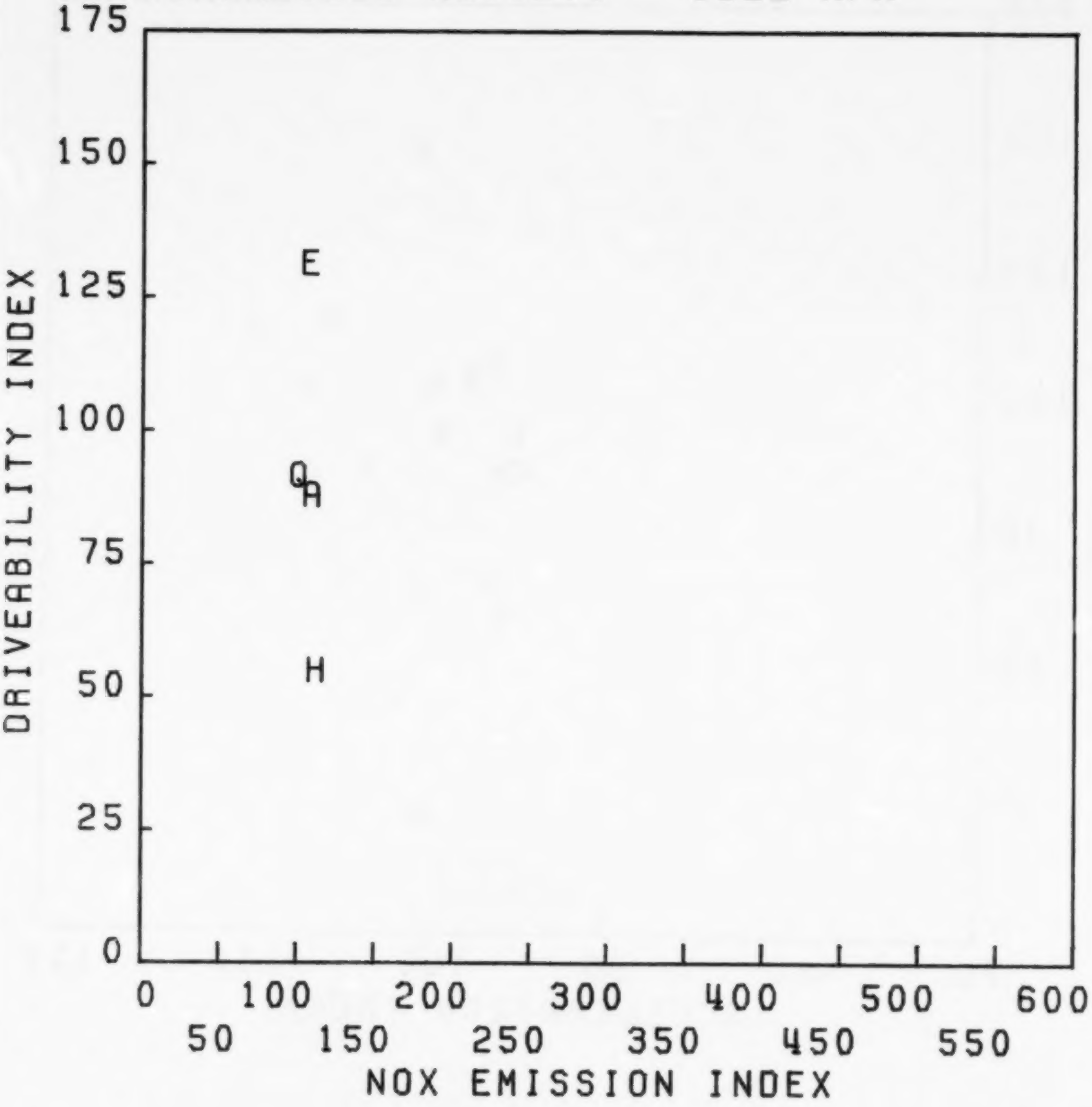

NORMALIZED RESULTS - IDLE RPM
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
ACCELERATION INDEX
70
80
90
100
110
120
E
Q
A
H

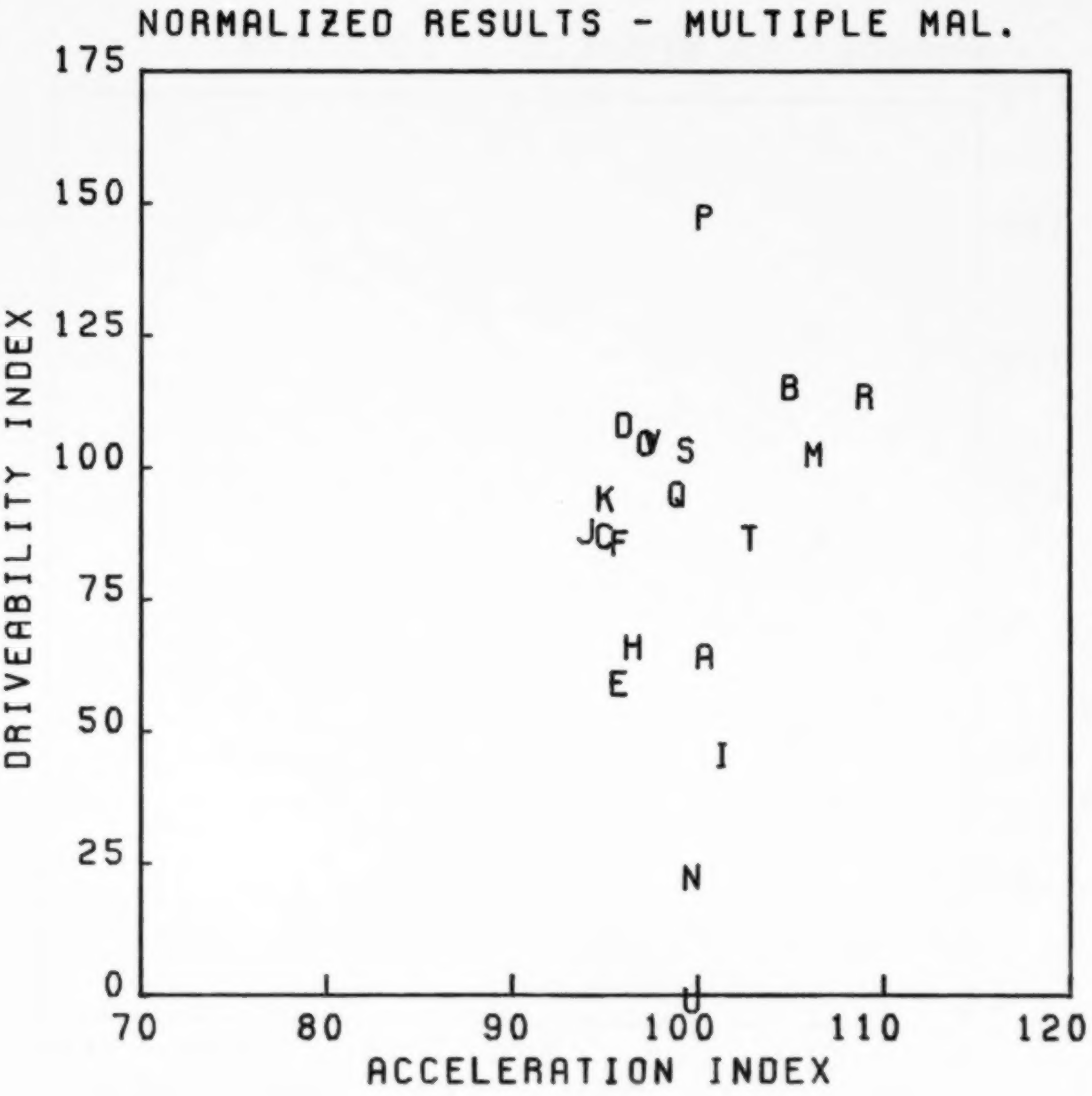

NORMALIZED RESULTS - IDLE RPM
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
75
100
125
FTP FUEL CONSUMPTION INDEX
E
Q
A
H

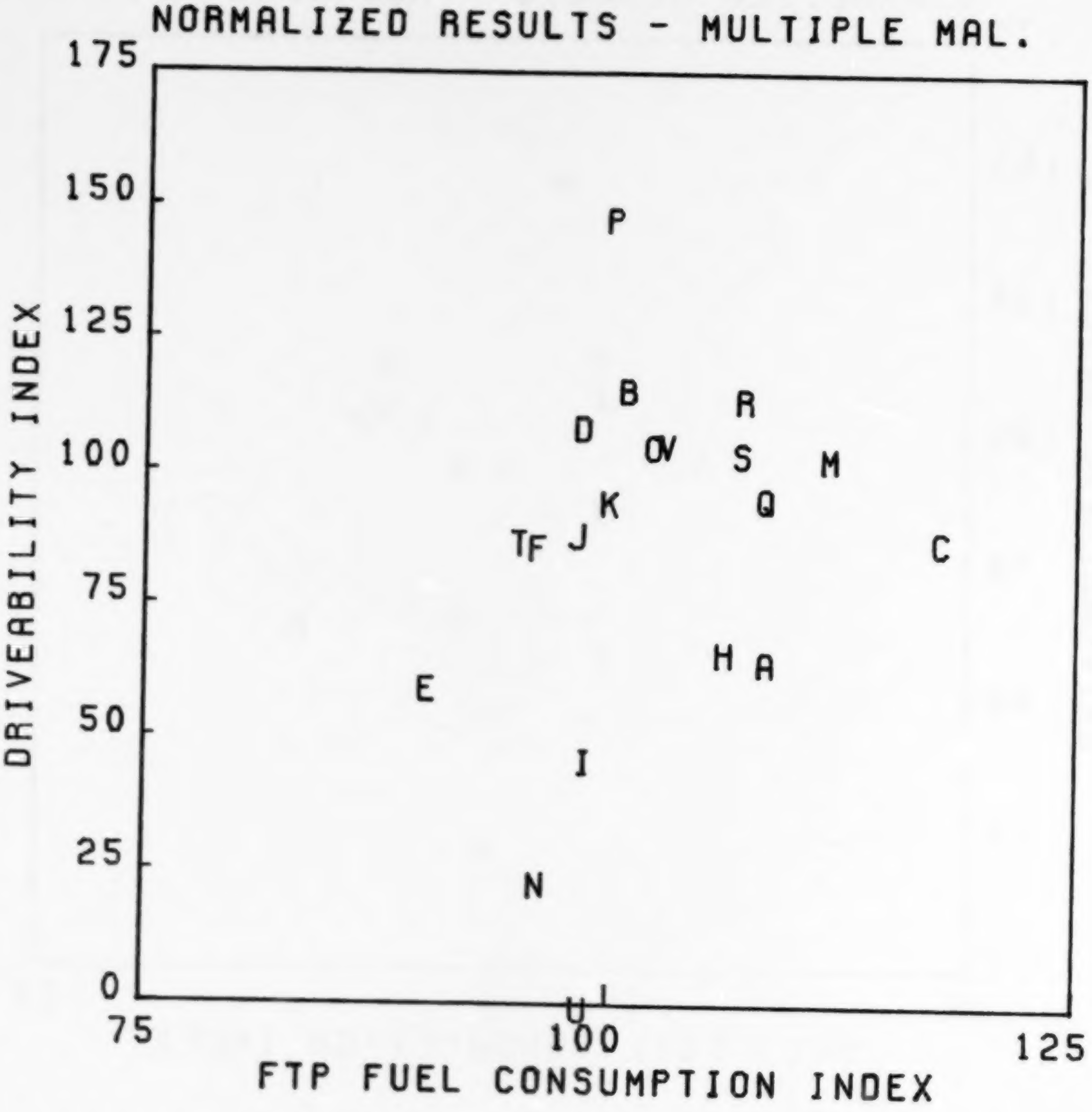

NORMALIZED RESULTS - IDLE RPM
175
150
125
100
75
50
25
0
DRIVEABILITY INDEX
E
Q
A
H
75
100
125
HFET FUEL CONSUMPTION INDEX

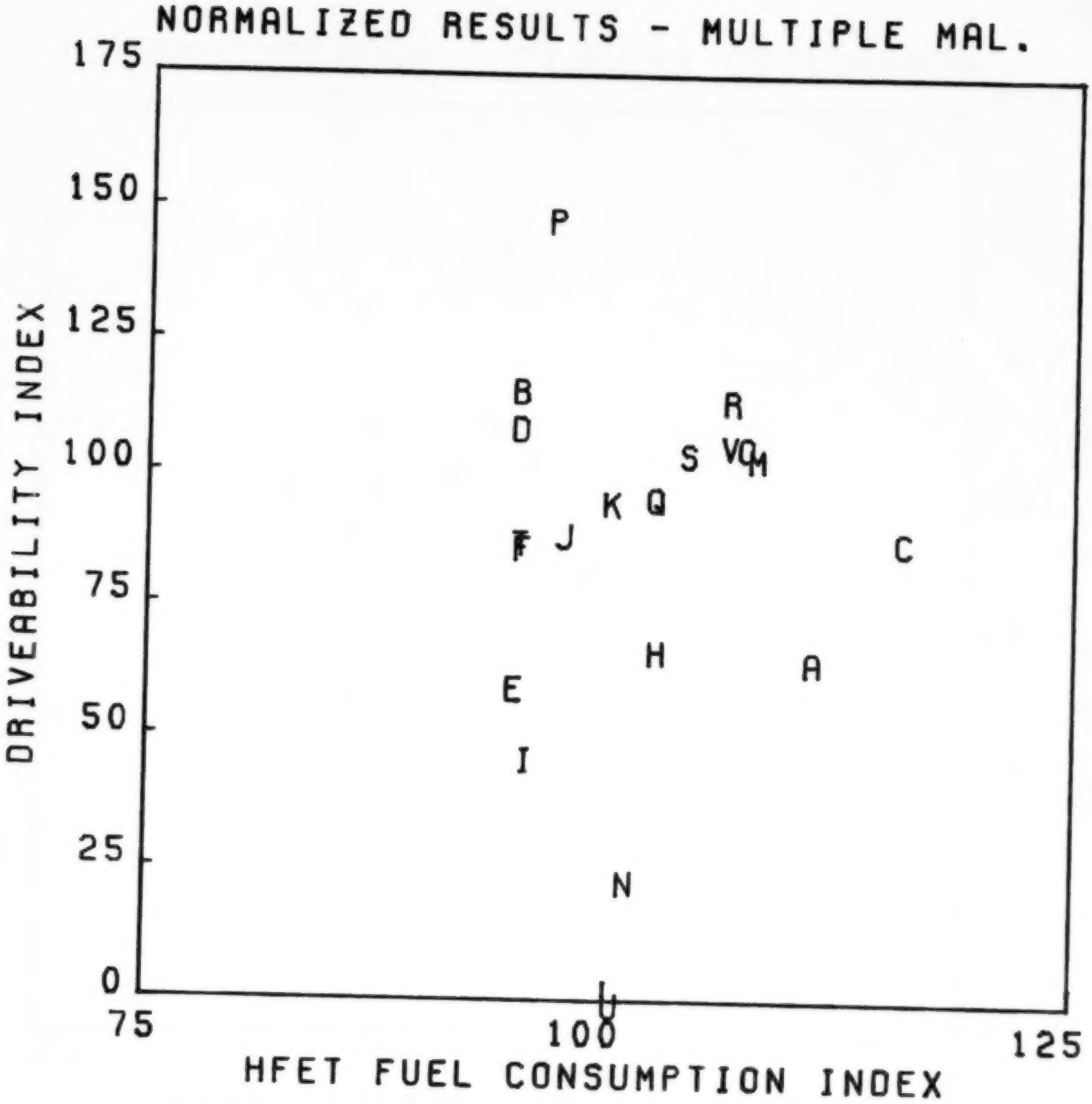

NORMALIZED RESULTS - IDLE RPM
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
E
Q
A
H
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX

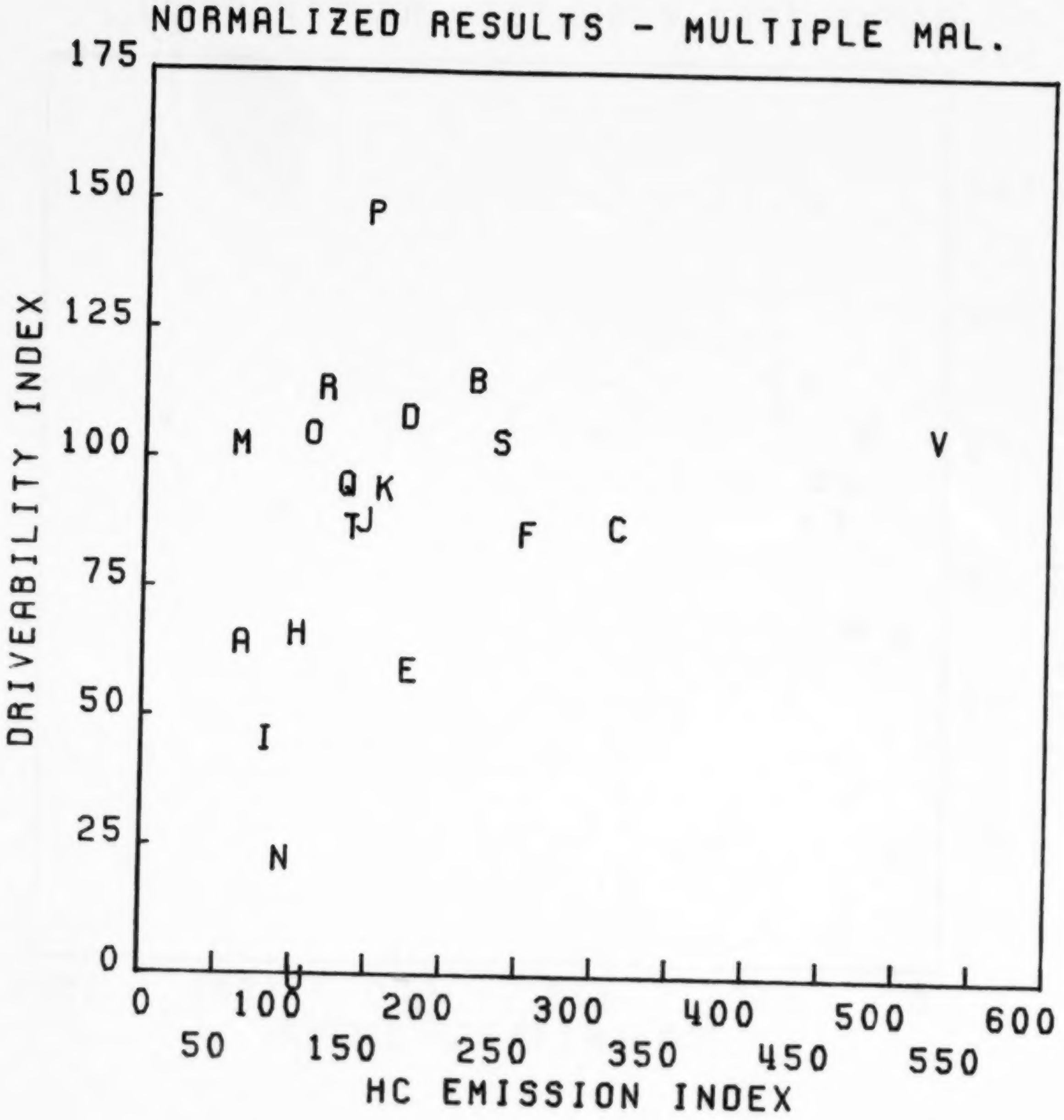

NORMALIZED RESULTS - IDLE RPM
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
CO EMISSION INDEX
0
300
600
900
1200
1500
E
A
Q
H

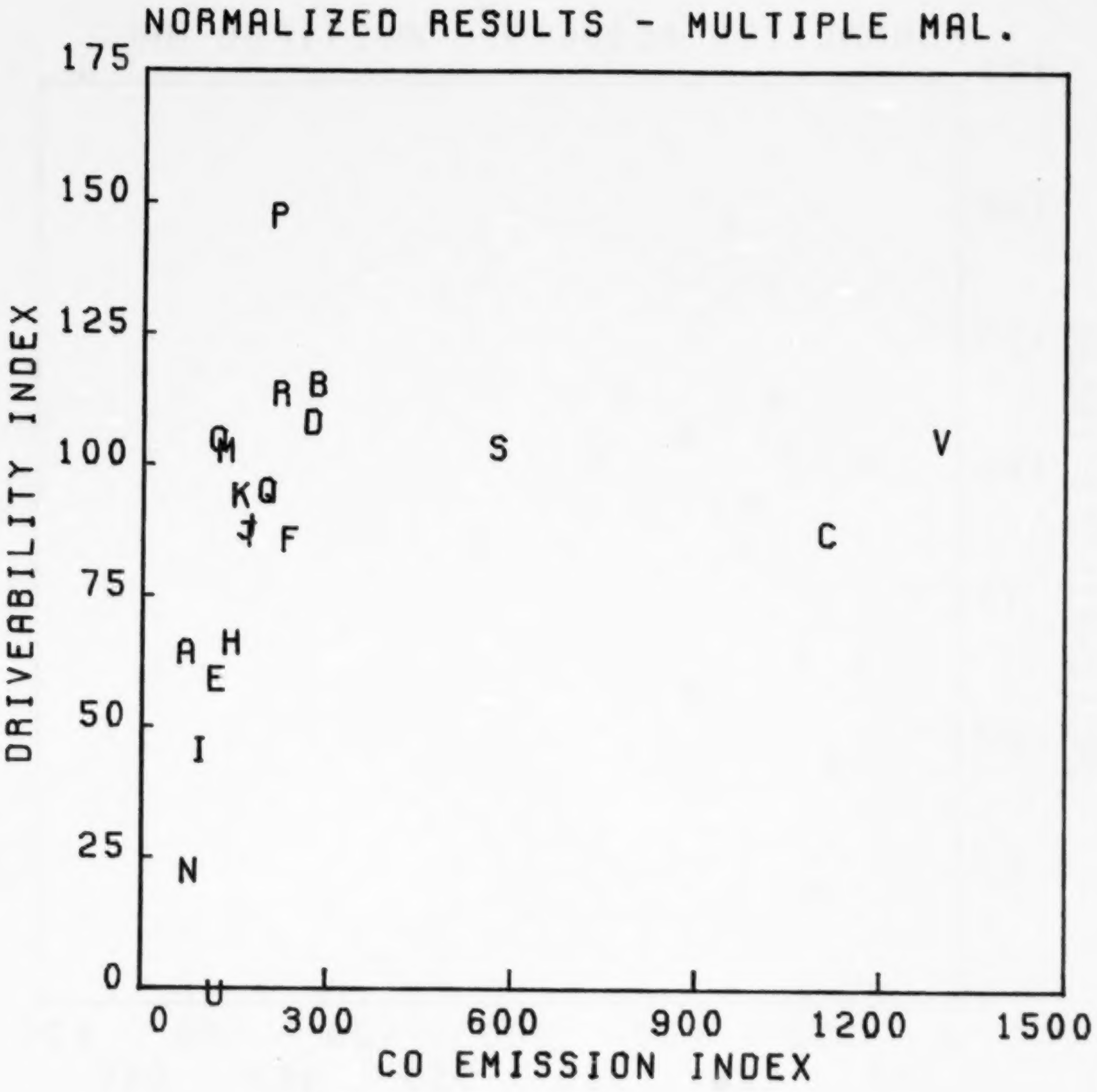

NORMALIZED RESULTS - IDLE RPM

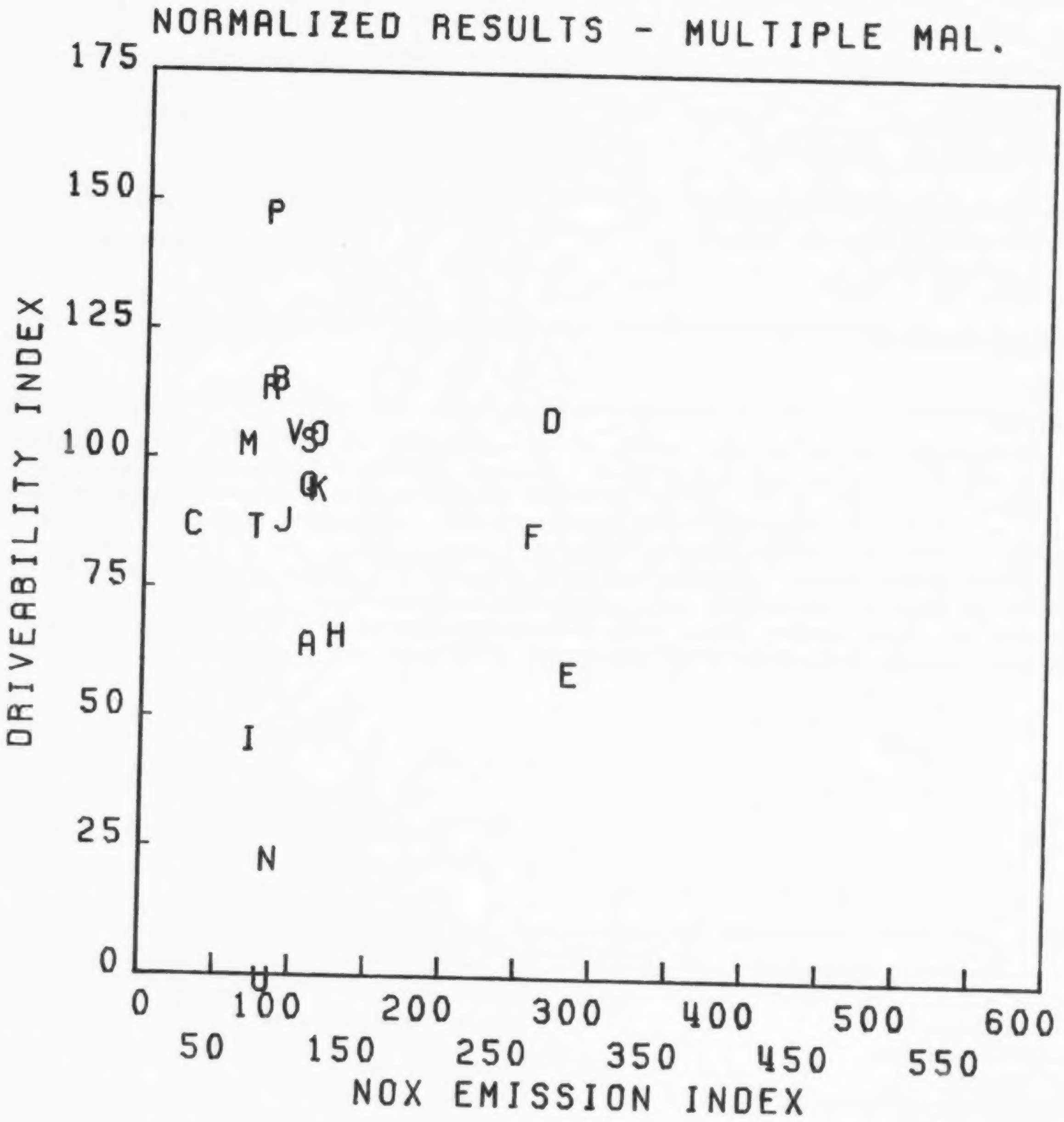

NORMALIZED RESULTS - MULTIPLE MAL.
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
ACCELERATION INDEX
70
80
90
100
110
120
P
B
R
D
O
S
M
K
Q
J
C
F
T
H
A
E
I
N
U


NORMALIZED RESULTS - MULTIPLE MAL.
DRIVEABILITY INDEX
FTP FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
P
B
R
D
OV
S
M
K
Q
T
F
J
C
H
A
E
I
N
U


NORMALIZED RESULTS - MULTIPLE MAL.
DRIVEABILITY INDEX
HFET FUEL CONSUMPTION INDEX
175
150
125
100
75
50
25
0
75
100
125
P
B
D
R
S
V
Q
M
K
Q
T
F
J
C
H
A
E
I
N
U
L


NORMALIZED RESULTS - MULTIPLE MAL.
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
P
R
B
D
O
M
S
V
Q
K
T
J
F
C
A
H
E
I
N
U
0
50
100
150
200
250
300
350
400
450
500
550
600
HC EMISSION INDEX


NORMALIZED RESULTS - MULTIPLE MAL.
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
CO EMISSION INDEX
0
300
600
900
1200
1500
P
R
B
D
O
M
S
V
K
Q
J
F
C
A
H
E
I
N
U


NORMALIZED RESULTS - MULTIPLE MAL.
DRIVEABILITY INDEX
175
150
125
100
75
50
25
0
NOX EMISSION INDEX
0
50
100
150
200
250
300
350
400
450
500
550
600
P
R
B
V
S
O
M
D
Q
K
C
T
J
F
A
H
E
I
N
U